THE MAGAZINE OF FLUID POWER

Hydraulics & Pneumatics

NOVEMBER 1961

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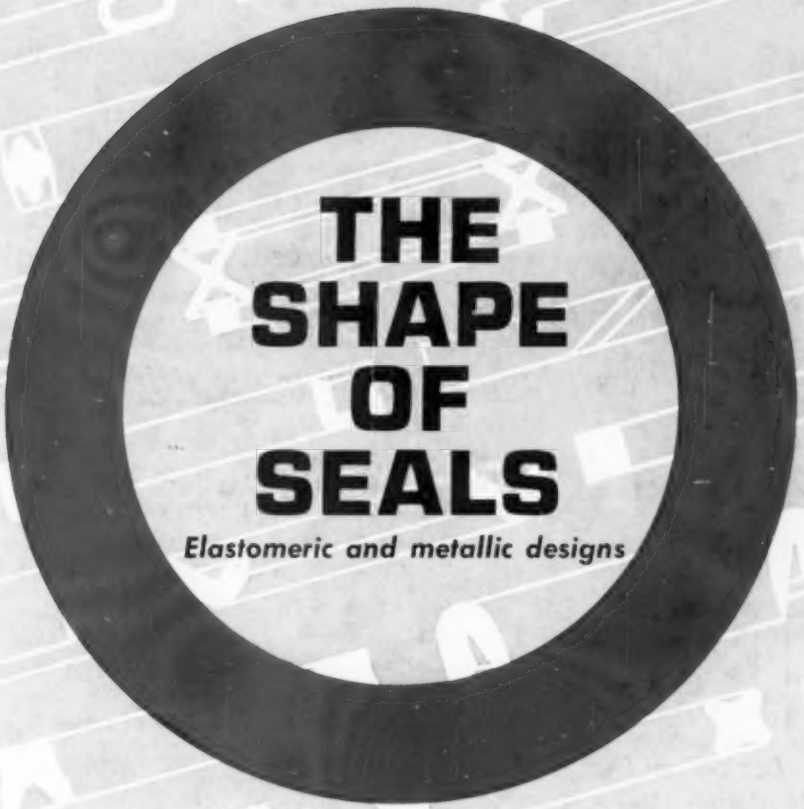


THE SHAPE OF SEALS

Elastomeric and metallic designs

PUMP DESIGN BY FORCE BALANCE

CALCULATING CRITICAL PRESSURE SURGES

USE GRAPHS FOR OPTIMUM SNUBBER DESIGN

AN INDUSTRIAL PUBLISHING CORPORATION MAGAZINE

Ruggedly Built

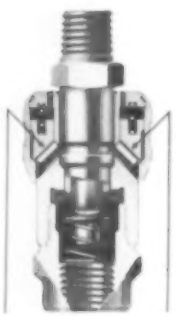
AND THOROUGHLY PROVED BY YEARS OF HARD EVERYDAY USE IN THOUSANDS OF PLANTS

HANSEN

QUICK-CONNECTIVE

PUSH-TITE COUPLING

As easy as plugging in your electric shaver



Here's the fluid line coupling that can really take it. The ability of Hansen Push-Tite Couplings to withstand severe service—with practically no maintenance—has been thoroughly proved by years of hard, everyday use in thousands of plants.

To connect a Hansen Push-Tite Coupling, you merely push the Plug into the Socket—as easily as plugging in your electric shaver. Flow is automatic—instantaneous. Plug swivels freely—no kinking of hose. To disconnect, pull back sleeve on Socket. Instantly and automatically, Socket shuts off flow of air or liquid.

QUICK CONNECTION AND DISCONNECTION

INSTANT AUTOMATIC FLOW OR SHUT-OFF

Leak-Proof Minimum Wear Locking Device

Locking pins in Socket afford uniform large area contact with Plug—thereby preventing wear and subsequent leakage. The socket head, containing locking device, is factory assembled into a rugged integral unit which cannot be readily injured or have component parts lost by casual tampering.

Write for the Hansen Catalog

Here is an always ready reference when you want information on fluid line couplings in a hurry. Lists complete range of sizes and types of Hansen One-Way Shut-Off, Two-Way Shut-Off, and Straight-Through Couplings.

QUICK-CONNECTIVE FLUID-LINE COUPLINGS for

COMPRESSED AIR
HYDRAULIC FLUIDS
WATER • VACUUM
STEAM • GASOLINE
ACETYLENE • REFRIGERANTS
OXYGEN • OIL • GREASE
COOLANTS • LP-GAS

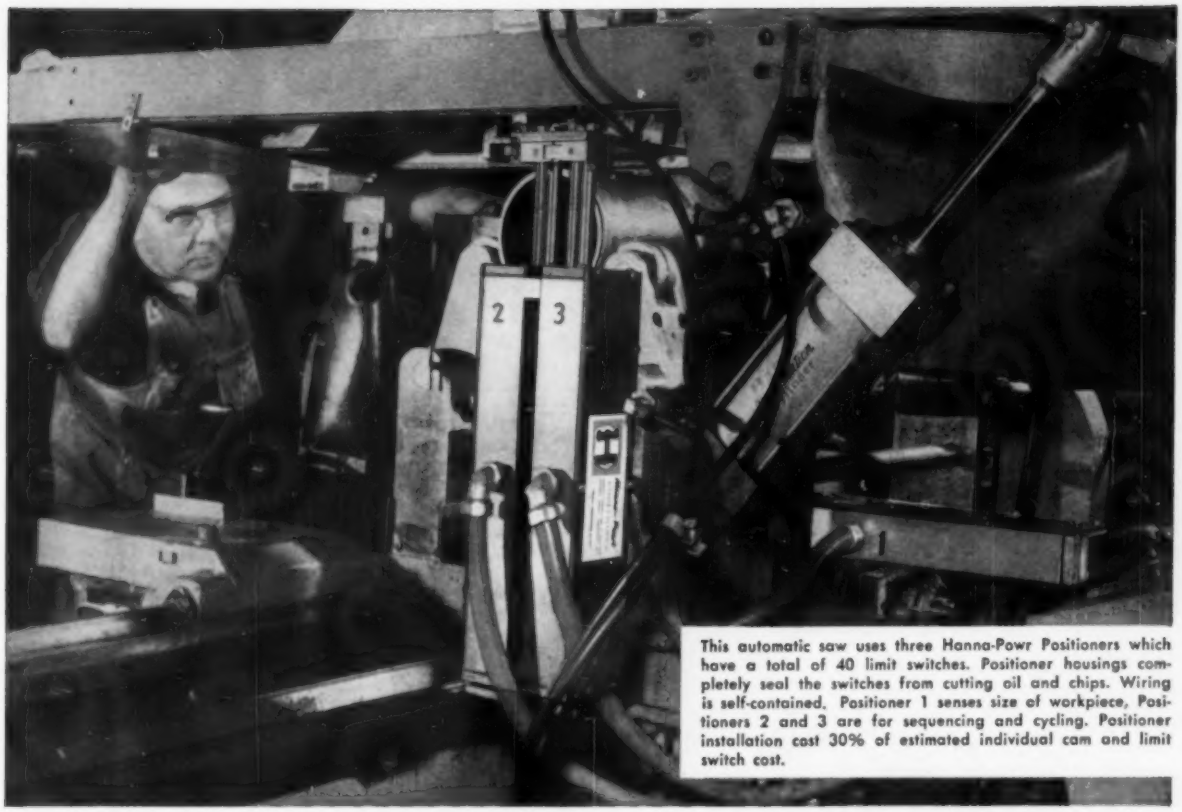
Representatives in Principal Cities... See Yellow Pages

SINCE 1915 **QUICK-CONNECTIVE FLUID LINE COUPLINGS**

THE HANSEN MANUFACTURING COMPANY

4031 WEST 150th STREET • CLEVELAND 35, OHIO

Circle **71** on Reader Service Card



This automatic saw uses three Hanna-Powr Positioners which have a total of 40 limit switches. Positioner housings completely seal the switches from cutting oil and chips. Wiring is self-contained. Positioner 1 senses size of workpiece, Positioners 2 and 3 are for sequencing and cycling. Positioner installation cost 30% of estimated individual cam and limit switch cost.

Start a cam and limit switch COST REDUCTION PROGRAM!

You can cut cam and limit switch costs up to 70% by using the Hanna-Powr Positioner — a compact, dust and water-tight housing containing cam rods and limit switches.

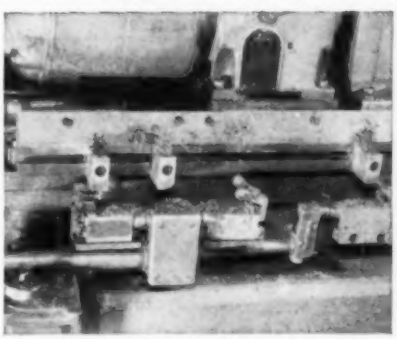
Because the Positioner is a pre-engineered assembly, it saves time used in designing special cams and mountings. Installation costs are cut, too, because it is only necessary to mount one box (4 screws) rather than individual switches and cams. Wiring is greatly simplified. The Positioner housing serves as a junction box—one conduit connection does it.

The switches can be moved easily and locked quickly in place after installation. This speeds set-up time for new jobs and makes pre-calculation of stops unnecessary. Safety is another big advantage—the switches cannot be tripped accidentally.

In addition to lower initial costs —maintenance, replacement, and down-time costs are cut. Switches last longer due to the protection (from dirt, chips, fluids and damage) afforded by the sturdy, extruded aluminum housing.

Use Hanna-Powr Positioners for cycling, sequencing, positioning, sensing and indicating. Many are in use and have been thoroughly tested in a variety of applications. It's a practical approach to automation.

Positioner containing switches and cam rods. Up to 28 switches per foot of travel. Any travel to 8 feet. Takes standard miniature or heavy duty limit switches, single or double throw.

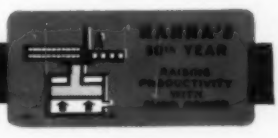


Examine your cam and limit switch costs. $35 to $75 per switch is the cost companies have fixed for designing, machining, installing, wiring, and adjusting limit switches and cams. This photo shows a typical high cost installation where oil, chips and accidental damage cause high failure rates and increased maintenance costs.

Write for complete catalog or consult Sweets' Product Design File section 9A/HA. Your Hanna Representative will also give you complete information—see the yellow pages under cylinders.

Hanna Engineering Works

1741 Elston Ave., Chicago 22, Illinois
AIR AND HYDRAULIC CYLINDERS, VALVES, POSITIONERS



MINNESOTA MR RUBBER

FACTS for FILING on QUAD·RINGS®

- POSITIVE SEALING UNDER ALL CONDITIONS
- ELIMINATES ALL SPIRAL TWIST FAILURE
- FOUR FLEXIBLE SEALING SURFACES
- LOW FRICTION INSTALLATION
- HIGH DENSITY INJECTION MOLDED
- RUBBER COMPOUNDS TO FIT APPLICATION

POSITIVE SEALING UNDER ALL CONDITIONS
The MR QUAD-RING gives superior sealing in reciprocating, rotary, and static applications at pressures ranging from 0 on up.

ELIMINATES ALL SPIRAL TWIST FAILURE—This costly cause of O-ring failure is eliminated because the relatively square cross-section of the QUAD-RING will not roll.

FOUR FLEXIBLE SEALING SURFACES—gives double the sealing effectiveness of the O-ring because of the exclusive seal design. It prevents leakage and requires less squeeze.

LOW FRICTION INSTALLATION—is made possible because of the exclusive quadrilateral design. This permits much higher rotary speeds and gives the seal much longer life.

HIGH DENSITY INJECTION MOLDED—All QUAD-RINGS are molded by MR's exclusive injection molding process to give an exceedingly dense product. There are no voids to cause seal failure.

RUBBER COMPOUNDS TO FIT APPLICATIONS
MR compounds are designed to give the best possible service, using basic polymers such as natural or synthetic rubber, silicone or any other that will perform best under the specific conditions.

Quad Rings are manufactured under U. S. patents RE 24332 and 2,873,132

FOR MORE INFORMATION AND COPY OF THE QUAD-RING APPLICATION AND INSTALLATION HANDBOOK . . .

WRITE ON YOUR LETTERHEAD FOR A FREE "MR FACTS FOR FILING" COVER.

WRITE: MINNESOTA MR RUBBER

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Hydraulics & Pneumatics

VOLUME 14/NUMBER 11

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THE MAGAZINE OF FLUID POWER

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NFPA NATIONAL FLUID POWER ASSOCIATION

FC FRANCHISE CIRCULATION

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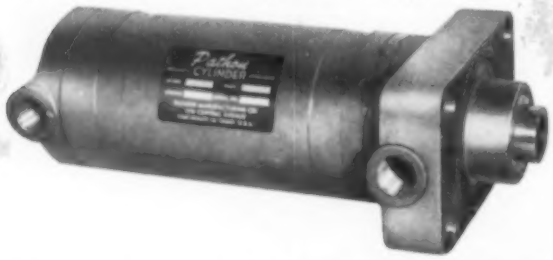
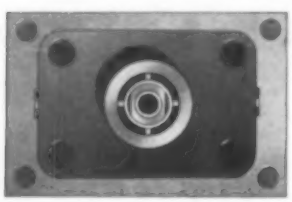
BPA

Pathon has Something *for Everybody*



Pathon Cylinders are designed to give you a highly practical cylinder that fits into almost every situation where a hydraulic cylinder is needed. Maintenance is at an absolute minimum because Pathon Cylinders are simple and easier to take apart and put together.

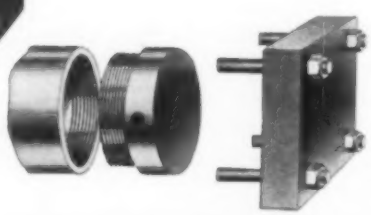


For the Designer

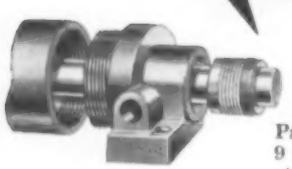
Pathon's compact design saves valuable space, makes your designing job easier, and gives your equipment added dependability with a modern rugged appearance.

For the User

Pathon's screw thread head design gives you up to 40% more strength than most tie-rod cylinders. This increased strength means less maintenance, longer life.



For the Maintenance Man



Rod packing and bearing is externally replaceable and any part can be replaced without complete disassembly and the resulting "basket full of parts."

Pathon Hydraulic Cylinders are available in 9 mounting types, thirteen bore sizes—1⅛", etc., through 14", and three Series—for 1000 PSI, and 2000 PSI and 3000 PSI.

Write for Bulletin No. 22-A

Pathon MANUFACTURING COMPANY

3823 PACIFIC AVE. • CINCINNATI 12, OHIO

FLUID OPERATED AND CONTROL EQUIPMENT

Circle **119** on Reader Service Card

Hydraulics & Pneumatics

THE MAGAZINE OF FLUID POWER

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Published monthly. Controlled circulation postage paid at Pontiac, Illinois. Printed in U.S.A.

Please return 3579 forms to 812 Huron Road, Cleveland 15, Ohio.

NEW PRODUCTS

NEW "HDP" HOSE ASSEMBLIES BY ANCHOR FOR HIGH PRESSURE COMPRESSED GAS SERVICE

A completely new type of hose assembly has been developed by Anchor Coupling Co. Inc. specifically for aircraft and missile high pressure compressed gas ground servicing. These new assemblies have an inner tube of "HDP" (a specially compounded high density polyethylene material) resistant to the effusion of high pressure gases and inherently smooth and clean. The "HDP" inner tube is reinforced with stainless steel wire braids and spiral plies. The reinforcement is protected with a tough perforated neoprene cover resistant to abrasion and exposure. This new type hose assembly is now covered by Military Specification MIL-H-26666A and is recommended for high pressure pneumatic ground servicing in the temperature range of −65°F to +160°F with compressed air, nitrogen, helium or other inert gases. Working pressure for the -4, -6, -8, and -12 size is 4000 psi and a -6 size is available for 6000 psi. Assemblies are available in continuous lengths up to 50 feet with stainless steel couplings and 37° flare swivel female ends to mate with male end fittings conforming to MS33656. The assemblies are furnished to the cleanliness requirements of the Mil-Spec. or to the customers' individual requirements. "HDP" hose assemblies to the requirements of MIL-H-27462 for 8500 psi working pressure are under development and will be available soon. "HDP" assemblies were developed by and are available from Anchor Coupling Co. Inc., 369 North Fourth Street, Libertyville, Illinois.

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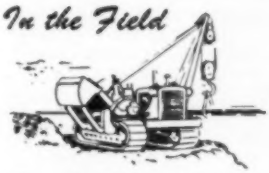
In the Field



On the Road

In the Shop

Andy Anchor says:

"The Anchor representative who calls on you is a qualified specialist with years of experience in the hydraulic field. He will welcome an opportunity to help you with your hydraulic plumbing problems.

Engineers and operators rely on these easily applied, streamlined Anchor Clamp-Type Couplings for fast, emergency repair and field service, as well as original equipment application.

Designed to accommodate normal variations in hose, they can be applied in the field with no tools other than a pair of automotive-type wrenches, and once applied, provide a sure, safe, leakproof connection that will remain intact up to the burst point of 2 and 3-wire braid hose.

Anchor Clamp-Type Reusable Couplings are supplied in high, medium or low pressure styles, for 3-Wire, 2 Heavy Wire, 2-Wire, 1-Wire, and Hi-Burst 2-Rayon Braid Hose, as well as Spiral Wire Suction Hose.

Write for Catalog No. 304.

ANCHOR COUPLING CO. INC.

368 North Fourth Street, Libertyville, Ill.
Branch Plants: Dallas, Tex., Plymouth, Mich.

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MARVEL

FOR DEPENDABLE PROTECTION

Synclinal SUMP TYPE

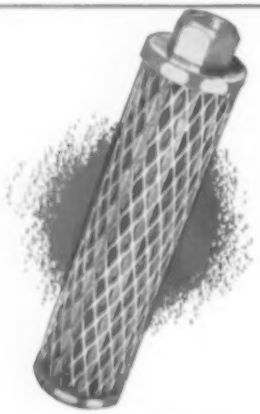
CAPACITIES:
5—8—10—20—30—50—75 and 100 G.P.M.

PIPE SIZES:
¾"—1"—1¼"—1½"—2"—2½" and 3".

CONNECTIONS:
Coupling—Male Nipple.

BY-PASS VALVE:
Not Available.

For use with regular petroleum base Hydraulic Oils, Coolants, Lubricants, all types of Fire-resistant Hydraulic Fluids and Water.



Tandem Synclinal SUMP TYPE

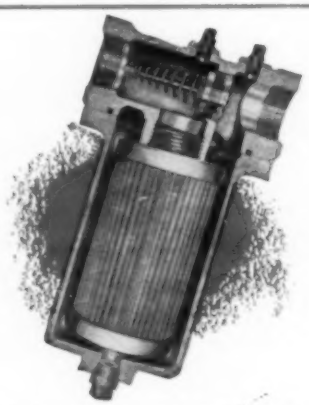
Designed to supply requirements for greater filtering area where installation of two or more single units are not possible due to space limitations in tank.

PIPE SIZES:
¾"—1"—1¼"—1½"—2"—2½" and 3".

CONNECTIONS:
Coupling—Male Nipple.

BY-PASS VALVE Not Available.

For use with regular petroleum base Hydraulic Oils, Coolants, Lubricants and all types of Fire-resistant Hydraulic Fluids and water.



Bonded SUMP TYPE

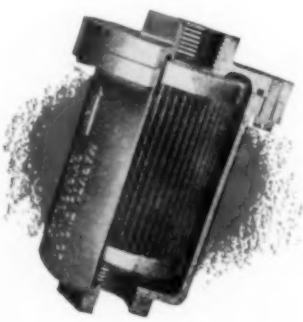
CAPACITIES:
10—20—30—50 and 75 G.P.M.

PIPE SIZES:
1"—1¼"—1½"—2" and 2½".

CONNECTIONS:
Coupling—"O" Ring—Male Nipple.

BY-PASS VALVE:
Available with or without By-Pass Valve.

For use with regular petroleum base Hydraulic Oils, Coolants, Lubricants and all types of Fire-resistant Hydraulic Fluids.



SYNCLINAL FILTERS

on all hydraulic and other low pressure circulating systems

Synclinal LINE TYPE

CAPACITIES:
5—8—10—20—30—50—75 and 100 G.P.M.

PIPE SIZES:
¾"—1"—1¼"—1½"—2"—2½" and 3".

BY-PASS VALVE:
Not available.

OPERATING PRESSURES:
Up to 80 p.s.i.

For use with regular petroleum base Hydraulic Oils, Coolants, Lubricants, all types of Fire-resistant Hydraulic Fluids and Water.

Bonded LINE TYPE

CAPACITIES:
10—20—30—50 and 75 G.P.M.

PIPE SIZES:
1"—1¼"—1½"—2" and 2½".

MOUNTING BRACKET: All sizes are available with provision for mounting bracket, (also for Flange connection with mounting bracket provisions) if desired.

BY-PASS VALVE:
Available with or without.

OPERATING PRESSURE:
Up to 250 p.s.i.

OPERATING TEMPERATURES:
Up to 300° F.

For use with regular petroleum base Hydraulic Oils, Coolants, Lubricants and all types of Fire-resistant Hydraulic Fluids.

IN-LINE FILTER

CAPACITIES:
Up to 60 G.P.M.

PIPE SIZES:
(at both inlet and outlet)
¾"—1"—1¼" and 1½" **NPTF.**
1⅝-12, 1⅞-12 and 1⅞-12 **J.I.C.**

FLANGE CONNECTIONS:
1¼" and 1½"

BY-PASS VALVE:
Available with or without By-Pass Valve.

For use with regular petroleum base Hydraulic Oils, Coolants, Lubricants and all types of Fire-resistant Hydraulic Fluids.

QUALITY

DEPENDABILITY

EFFICIENCY

QUALITY—All Marvel Synclinal Filters are designed and constructed of the highest quality materials and workmanship to insure maximum protection on all hydraulic and other low pressure circulating systems. *They Meet J. I. C. Standards.*

DEPENDABILITY—The dependability of Marvel Synclinal Filters is attested by the fact that—OVER 900 Original Equipment Manufacturers install them as standard equipment.

EFFICIENCY—Filtering media in all Marvel Synclinal Filters is Monel wire cloth and available in mesh sizes of 20-30-40-50-60-80-100-150 and 200. Stainless wire cloth in these sizes supplied on specification. Before fabrication into Marvel Synclinal Filters, all wire cloth is subjected to rigid inspection at our plant to assure the utmost in filtration efficiency. *Only selected top quality wire cloth is used.*

EASY MAINTENANCE—All Marvel Synclinal Filters can be cleaned easily and thoroughly "on the spot" in a matter of minutes, resulting in the equivalent of a brand new filter, ready for another long period of efficient and dependable service.

Line type filters operate in any position and may be serviced without disturbing pipe connections.

IMMEDIATE DELIVERY
A phone call will start your shipment on its way TODAY!

For Further Information, Wire, Write or Phone

MARVEL ENGINEERING COMPANY

7227 North Hamlin Ave. • Chicago 45, Illinois • Phone JUniper 8-6023

Please send me information on Marvel Filters as indicated. AH-11

☐ Sump Type ☐ In-Line ☐ For Hydraulic Oil ☐ For Coolants or Lubricants
☐ Line Type ☐ Tandem ☐ Fire Resistant Fluids ☐ For Water

Name _____

Company _____

Address _____

City _____ Zone ____ State _____

NEW

NORGREN PRECISION PRESSURE REGULATOR

high sensitivity and exact accuracy of air pressure regulation

The new Norgren Precision Pressure Regulator, Type 20AS, is designed for air-gauging, laboratory use, pilot regulation and other applications where a high degree of accuracy and sensitivity is required for air pressure regulation. Operation of the new Type 20AS regulator is characterized by the following:

1. **Accurate regulation at all flows up to the maximum flow recommended for ¼" pipe. This is more than 2 times the flow previously possible with instrumentation regulators.**
2. **Immediate response and high sensitivity.**
3. **Exact repeatability and freedom from drift over short or long time operations.**
4. **Accurate regulation—even at delivery pressures below 1 psi.**

SPECIFICATIONS:

0-60 psig secondary pressure
0-150 psig primary pressure
32° to 160° F temperature range
¼" pipe size

Flow curves and regulation curves of the 20AS precision regulator are included in Norgren brochure NA-7—see below.

For complete technical information about the new Norgren Precision Pressure Regulator, call your nearby Norgren Representative listed in your telephone directory—or write factory for brochure NA-7.

Founded In 1926

C. A. NORGREN CO.

3402 SOUTH ELATI STREET • ENGLEWOOD, COLORADO

Circle **109** on Reader Service Card

. . . Fluid Power news

OILGEAR 40 Years of Fluid Power

Report No. 11,807 From Oilgear *Application-Engineering* Files

How OILGEAR *Any-Speed* Drive Systems on revolutionary, new, continuous pipe mill provide up to 30% over and under base lineshaft speed for each stand—controlled to ±0.1% accuracy . . . maintain constant interstand speed ratios.

USER: *Lorain (Ohio) Works, National Tube Division, United States Steel Corp.*
Machine Builder — Aetna Standard Division, Blaw-Knox Co., Pittsburgh, Pa.
Differential Drive Manufacturer — Beloit Iron Works, Beloit, Wis.

PROBLEM: To provide accurate, efficient, independent, variable speed drive and control systems between a 1000hp lineshaft drive and 14 form-weld, stretch-reduce stands, and rotary flying hot saw of a new, continuous, buttweld pipe mill designed to produce approx. 237,000 tons of 1¼" to 4" buttweld pipe annually from flash-welded, endless webs of skelp. Delivery speeds range from 700 ft/min. of 1¼" pipe to 150 ft/min. of 4" pipe.

DRIVE REQUIREMENTS: 1. "Hard", non-resilient characteristics of direct gearing — with provision for infinite, variable speed control of any or all stands from 30% under to 30% over predetermined base lineshaft speed. 2. Accurate, preset, speed ratios between stands, capable of precisely maintaining transmitted differential loads to 150 hp — without drift — regardless of load change or lineshaft speed variation. 3. Optional, remote, automatic, "preset", and remote manual control. 4. Direct-reading, constant, visual indication of torque being pulled at each stand, and speed ratios between all adjacent stands. 6. Drive a rotary, flying cut-off saw at maximum mill delivery speeds — synchronized with speed of last active mill stand. 7. Must be compact, with trouble-free dependability for continuous, heavy-duty drive service. 8. One reputable source and responsibility preferred.

OILGEAR *Application-Engineered* HYTAC* Drive System For Continuous, Buttweld Pipe Mill

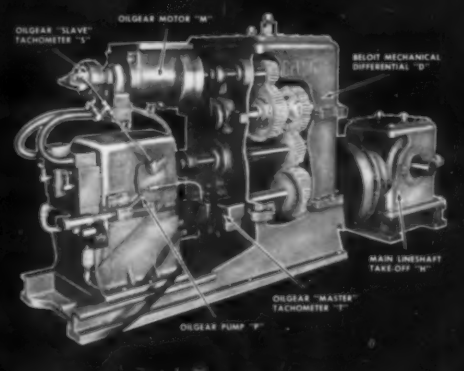
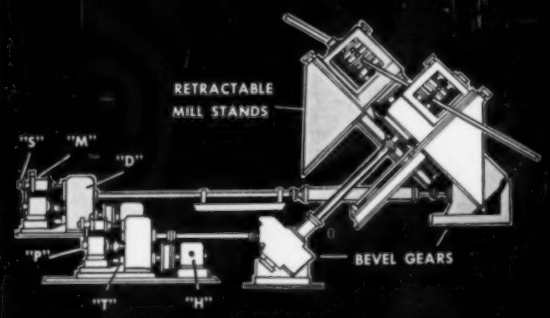


Photo Courtesy of Beloit Iron Works

LEFT: Fluid from Master Tach (T) gives stand drive speed command to control on Pump (P). Slave Tach (S) — direct-connected to Drive Motor (M)—feeds back a flow signal proportional to actual drive speed. Through remote, pushbutton control stations connected to electric pilot motor on Master Tach (T), operator can vary speed of each, or all stands infinitely up to 30% over or under base line-shaft speed . . . with accuracy to ±0.1%. **RIGHT:** Two typical stands of seven stand stretch-reduce mill. Each stand is mounted on a steel sled—45° to horizontal—90° in relation to each other. Sled stands are movable by a hydraulic cylinder. A hydraulic clamping mechanism holds sleds in selected positions. Six pipe sizes can be rolled without changing rolls.



SOLUTION: Oilgear *Application-Engineered HYTAC** — Beloit Mechanical Differential Drives provide precise speed and ratio control for 7 form-weld stands, 7 stretch-reduce stands, and a rotary, flying cut-off saw. Overall mechanical efficiency has been determined as well above 90% at full load . . . with remotely controlled speed variable up to 30% over and under base lineshaft speed for any one or all stands — with accuracy maintained within ± 0.1%. Production speeds required for a given pipe size can be preset within a small fraction of 1% — and duplicated at any later date. In this precisely controlled process — a National Tube innovation — the buttwelded pipe is both elongated and reduced in diameter . . . *with wall thickness and pipe diameter held to extremely close tolerances by the accuracy of interstand speed ratios.* An Oilgear "Any-Speed" Drive and Control System automatically synchronizes the rotary, flying cut-off saw with maximum delivery speed of the last active stretch-reduce stand — to cut the continuous pipe in accurate, predetermined lengths.

BIBLIOGRAPHY: *Steel Magazine, Dec. 12, 1960, Page 86; Automation Magazine, May, 1961, Page 68; Steel Magazine, Jan. 30, 1961, Page 114; A paper — "Variable Speed Hydro-Mechanical Drive", by Charles W. Modersohn, Staff Engineer, Beloit Iron Works, presented at N.C.I.H., Oct. 21, 1960. ① See Oilgear Fluid Power NEWS 8, 11, 15, 16 — available on request.*

**HYTAC is an Oilgear Company registered trademark.*

Installation of Oilgear-Beloit Variable Speed Hydro-Mechanical Drive and Control Systems — successfully pioneered on paper machine drives ① — have exceeded originally specified requirements — without "start-up" problems . . . indicating the value of Oilgear's *Application-Engineering* teamwork throughout all stages of design, building, installation, and testing.

For accurate synchronization of multiple, tandem operations; for combining separate operations to handle webs, tows, or sheets — soft and fragile at one point, strong at another; for continuous operations where tension affects quality — or determines dimensional tolerances . . . all need MORE than conventional drives and controls — they need the precision of Oilgear "*Any-Speed*" Drives and Controls. User's state — "*For the lowest cost per year — with the most advanced, precision controls known to industry . . . it's Oilgear — the pace-setting pioneer!*"

For practical solutions to YOUR rotary or linear drive and control problems, call the factory-trained Oilgear Application-Engineer in your vicinity. Or write, stating your specific requirements, directly to . . . . .

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Application-Engineered "Any-Speed" Drive and Control Systems
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FLUID POWER LINES

from editor to reader

SEAL SHAPES . . Rapid developments have been coming along in seals of various shapes and materials, and for wide temperature and pressure ranges. Learning about all of them—especially the newer metallic and elastomeric types—can be an intricate research job. We've summarized main characteristics of over fifty seal shapes in the charts beginning on page 76. They range from the traditional O-rings and V-rings to the newer X-rings, labyrinths, and bellows. To use the charts, find your requirements in the specifications at top. Then follow the dots to see which seals meet them. Numbers correspond to the list of manufacturers which is included.

PUMP DESIGN . . . From Israel comes a mathematical development for designing axial piston pumps having port plates. In his article, *Pump Design by Force Balance*, Nissim Franco has examined forces on the port plate to derive equations for sizing the plate. Effectiveness of this method is shown by the curves which compare theoretical and actual design.

DESIGNING OUT SURGES . . . Cause of many hydraulic failures is repeated pressure surge which has unknowingly been built into a system. It stresses lines, connections, and seals, eventually causing leakage or even breakage. What causes pressure surge and how to calculate it for a particular design are discussed in the article on page 108. Interesting data is shown to compare effects of pressure surge in a 6000-psi system and a 1000-psi system.

GRAPHICAL SNUBBER DESIGN . . . An important part of designing an actuation system for an areospace vehicle is snubbing high speed actuators. Similar considerations apply to fast acting machine tool slides which are driven by a numerically controlled servo system. To reach the optimum of minimum snubbing load, stroke, and pressure, engineers at L-T-V Electronics have developed a graphical method for solving non-linear differential equations. The techniques which are explained in this month's Aerospace Section should also be valuable to designers of industrial servo systems.

CONTAMINATION TESTS . . . Starting on page 128, you'll find a detailed report on the August meeting of the American Society for Testing Materials, Aerospace Test Methods Section. This group has been active in preparing test methods for development, manufacture, and use of aerospace hydraulic fluids. Those now ready for trial or interim use include: *Recirculating Dynamic Test Method*, and *Microscopic Method for Sizing and Counting Particulate Contaminants*. In process are fluid sampling methods; determination of gel, radition, and biological contamination; and a non-recirculation dynamic test method.

PREVIEWS . . . Next month our annual aerospace issue will feature a comprehensive, state-of-the-art report on fluid power in space. A number of outstanding authorities have reviewed developments in their special areas. In January we'll bring you up to date with the Designers Guide Issue featuring manufacturers' specifications on hydraulic and pneumatic components. The February issue will meet the contamination problem head-on with a special section of articles on testing and filtration.

The world's largest line of air valves is also the most advanced because of the Ross engineering staff

Do you know these Ross air controls?

EASY MAINTENANCE

Rugged, dependable foot valve

The 600 valve series. Features maintenance without disconnecting piping, rugged construction and a variety of treadle options: double or single treadle; spring return or detent. Also available as a hand valve. 3-Way and 4-Way models, ¼".

AIR AUTOMATION

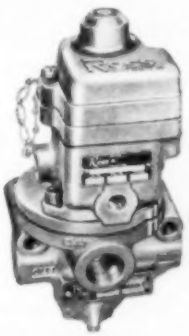
Time delay sequencing valves

The Ross Graymodel Valve is actuated by pilot air from another part of the circuit. Times in with cartridge in one position, times out if cartridge is reversed. Adjustable to 0 to 3 second delay.

RUGGED

More Comfort for Machine Operator

Push buttons may lead to sore fingers but not this palm button valve. 2⅜" button is comfortably convex. Valve is ruggedly built, available with or without key-locking feature. Red or green button, flange mounting. S-Way or 3-Way.



ECONOMY

Small valve does bigger valves work

The Pacer Headline Valve gives you highest capacity valve-size for valve-size of any solenoid valve on the market. Capable of rapid cycling, consumes little power. S-Way, 3-Way and 4-Way models. ¼" through 1½" pipe sizes.

For more information write us, or contact your nearby Ross representative. See our digest catalog in Sweet's

THE WORLD'S MOST COMPLETE LINE OF AIR CONTROL VALVES. AVAILABLE ALL OVER THE FREE WORLD.

Ross OPERATING VALVE COMPANY

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New, unique 2-stage hi-pressure hydraulic pumping units - dual volume and pressure

With 1½ H.P. universal motor, 4-way manual control valve, gauge and 2-gal. reservoir. Wt. 45 lbs.

With 3450 r.p.m. 1½ H.P. jet pump motor, 4-way solenoid valve and 2-gal. reservoir.

With 3 H.P. gasoline engine, 4-way manual control valve, gauge and 5-gal. reservoir.

"Tandem" hookup—two Vanguards in a single 7 gal. reservoir with single 4-way valve; produces twice the volume.

5-Cylinder, Axial Piston Pump (high-pressure stage)—precision-fitted pistons and cylinders are heat-treated, Nitride-hardened and honed to super finish.
Gear Pump (low-pressure stage)—precision fitted gears; hardened, ground and lapped. Supercharges high-pressure stage.

AVAILABLE IN TWO PRESSURE RANGES

- **VANGUARD VI, Y-60 Series—For operating pressures up to 6,000 p.s.i.**
- **VANGUARD X, Y-26 Series—For operating pressures up to 10,000 p.s.i.**

New OTC "Vanguard" complete power packages are versatile, precision-built units that handle high pressure, high force requirements, yet provide fast ram approach and return . . . no wasted time in getting the cylinder piston to and from the work!

6,000 P.S.I. MODEL WITH UNIVERSAL MOTOR DELIVERS:		10,000 P.S.I. MODEL WITH UNIVERSAL MOTOR DELIVERS:	
600 cu. in./min.	@ 100 psi	600 cu. in./min.	@ 100 psi
400 cu. in./min.	@ 500 psi	400 cu. in./min.	@ 500 psi
130 cu. in./min.	@ 1000 psi	80 cu. in./min.	@ 1000 psi
90 cu. in./min.	@ 6000 psi	50 cu. in./min.	@ 10,000 psi

A wide variety of accessories are available to utilize the "Vanguard's" exceptional performance: choice of motors; gasoline engine; 2 and 4-way lever control valves; 2 and 4-way solenoid valves; pressure switch; pressure regulating valve; manifold; reservoirs; gauges.

For complete information write for our new "Vanguard" brochure, No. V-2.

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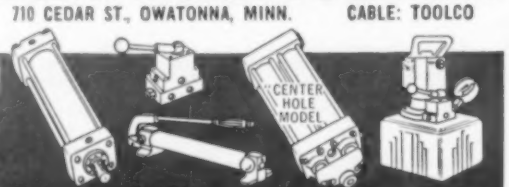
OTC



DESIGNERS AND MANUFACTURERS OF QUALITY HIGH PRESSURE HYDRAULIC COMPONENTS

Circle **112** on Reader Service Card

LETTERS to the editor

Valve pressure drop rating

TO THE EDITOR:

The article titled "Design with Pressure Drop Ratings" which appeared in the August issue indicates that a new rating method for valves has been introduced by a prominent manufacturer of fluid power components. In December 1957 we announced a catalog which graphically illustrated pressure drop in our directional control valves. Obviously our company is in agreement with this method of rating, and we are hopeful that other manufacturers will adopt this principle in rating valves.

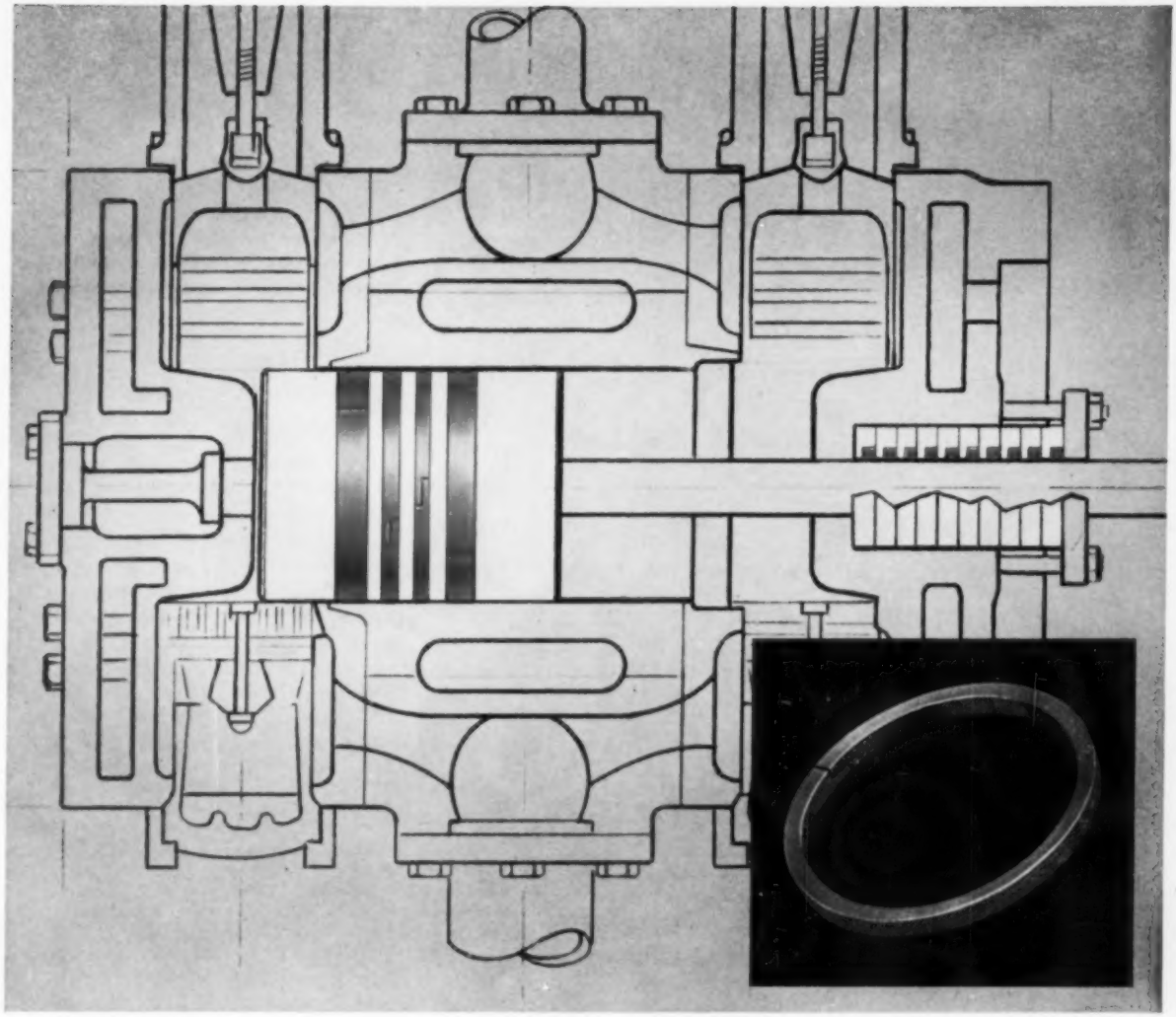
H. S. THOMPSON
Asst. Vice President, Sales Promotion
Commercial Shearing & Stamping Co.
Youngstown, Ohio

TO THE EDITOR:

It has been my responsibility to design several extensive hydraulic circuits for highway paving equipment in the past five years. We have used Commercial Shearing & Stamping valves almost exclusively, and their catalogs have had very complete valve performance curves. They plot internal pressure drop against flow for various numbers of valve spools and for different size valves. A red line across these curves indicates the pressure drops above which excessive heating is produced. These curves are based on an oil viscosity of 180 SSU at 100 F and an oil temperature of 140 F. We have found these curves to be very helpful in selecting the proper valve for each application. This is not a "blind" approach as your article stated, and is certainly not new.

ROBERT J. BEESON
Chief Engineer
Paving Div.
Jaeger Machine Co.
Columbus, Ohio

The new feature in the rating method explained in the August article was the listing of pressure



How piston rings of TEFLON® eliminated fire hazard and saved $4,500 per year

Oil contamination in an instrument air system caused serious problems in a large manufacturing plant. Oil plugging the lines not only led to heavy maintenance costs, but also created a dangerous fire hazard. Converting the eight instrument air compressors to piston rings of TEFLON solved the problems and saved the plant money.

The greatly reduced lubrication required with rings of TEFLON (no oil at all was added to the cylinder) eliminated the oil contamination and system plugging. In addition to cutting maintenance costs substantially, the rings of TEFLON lasted longer than previously used carbon rings, saving $3,000 per year in ring cost, and virtually eliminated cylinder wear, saving another $1,500 in cylinder refinishing.

Piston rings of TEFLON are your most logical and economical choice whenever reduced lubrication would be desirable . . . whenever problems of product contamination arise . . . whenever ring brittleness causes handling, installation, or operating difficulties. If you are buying a new compressor, specify rings and packings of TEFLON TFE resin. To convert your present equipment, check with your compressor manufacturer or qualified ring supplier for engineering and design assistance. For more information write to: E. I. du Pont de Nemours & Co. (Inc.), Dept. HP-11, Room 2526, Wilmington 98, Delaware.
In Canada: Du Pont of Canada Limited, Box 660, Montreal, Quebec.

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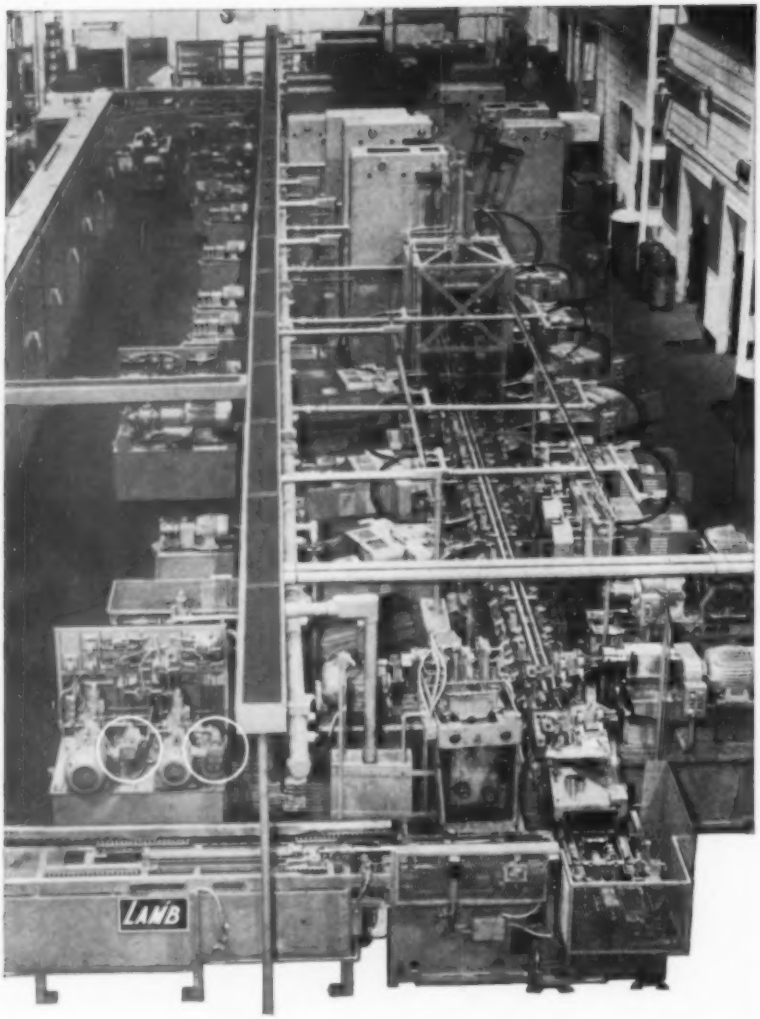
TEFLON is Du Pont's registered trademark for its family of fluorocarbon resins, including TFE (tetrafluoroethylene) resins and FEP (fluorinated ethylene propylene) resins



RELIABILITY-INSURED

with TELL TALE* Filters

Circled in the Lamb transfer machine are just two of the dozens of TELL TALE filters there. They are there because they help the precise hydraulic movements stay precise. You'd specify TELL TALE too, if you knew what they do. To find out, ask for our catalog.

**TELL TALE is a registered trademark of the Rosaen Filter Co. It signifies a line of filters that tell when they need cleaning, are easy to clean, and will never starve a pump. They are unique. Ask for our list of users.*

The ROSAEN FILTER Company
1774 EAST NINE MILE • HAZEL PARK (DETROIT), MICHIGAN

TELL TALE filters are available from Rosaen distributors and Vickers warehouses everywhere.

Circle 132 on Reader Service Card

LETTERS

drop values for each position of the valve, for each pair of ports, with flow in each direction. The article also gave formulas to correct for various viscosities and specific gravities.

Cost of air leakage

TO THE EDITOR:

Concerning the inquiry in the August issue on the cost of leakage in pneumatic systems, several years ago we made a study of this problem for a large midwestern transit bus system. Needless to say the figures shook up the bus maintenance section, and a campaign to reduce air loss was immediately initiated.

G. P. RICHARDS
Automotive Product Engineering
Wagner Electric Corp.
St. Louis, Missouri

Outdoor pneumatics

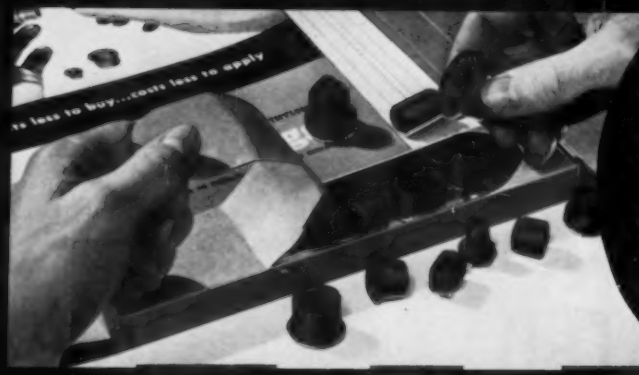
TO THE EDITOR:

We have a cylinder of compressed air, fitted with a pressure reducer to cut pressure to about 100 psi. Attached to this will be a quick-acting, solenoid-operated valve which can open and close quickly. This valve will be outdoors in a ventilated, unheated enclosure. Temperature variation will be approximately —40 C to +50 C. The valve must be leakproof because it may not operate for six months. Maintenance should be nil. The valve should not contain materials which shrink or deteriorate. Can you suggest a source for this component?

D. W. GARDNER
Transformer Engineer
ITE Circuit Breaker (Canada) Ltd.
Eastern Power Devices, Ltd. Div.
Port Credit, Ontario

We have suggested a firm in your area which should be able to assist you in designing this system. Also, the article "Hydraulic Circuit Breaker Keeps Watch on Itself" which appeared in the August issue should be of interest to you. ▼▼▼

Circle 123 →



here's your invitation to see how Caplugs can protect your products

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MAIL a free assortment of Caplugs, literature and prices to us, without obligation.

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molded of tough, flexible Polyethylene

unaffected by most chemicals

easy to apply... and remove

won't chip, break, shred, or collapse

Caplugs

A full family of closures to meet almost any need you can name . . . over 600 sizes in numerous styles and colors now in stock.

APPLICATIONS UNLIMITED
DEPENDABILITY UNLIMITED
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Meeting engineering demands for 20 years has meant continual upgrading for the Greer Accumulator. Today's reliability, safety and service are the result of this unmatched field and operational experience. Engineering application and service are available from any of the 23 field offices, distributors or factory personnel. Bring your engineering problem on standard accumulators or special adaptations to Greer.

Friction Free Bladder Types
3000 psi, 8 sizes: 10 gal., 5 gal., 2½ gal., 1 gal., 1 qt., 1 pt., 10 cu. in., 1½ cu in. 6000 psi, 3 sizes: 10 gal., 5 gal., and 2½ gal. The only type of its design approved under ASME codes of unfired pressure vessels. Approved by Coast Guard and I. C. C. regulatory bodies. Meets J.I.C. regulations.

Floating Piston Types
3000 psi, 14 sizes: 30 gal., 25 gal., 20 gal., 15 gal., 12 gal., 10 gal., 5 gal., 4 gal., 2½ gal., and 1 gal.; 116 cu. in., 60 cu. in., 30 cu. in., and 10 cu. in.

Spherical Types
1000-3000 psi, 3 sizes: 10", 7" and 5" diameters

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Circle 64 on Reader Service Card

FLUID POWER FORUM

Each month HYDRAULICS & PNEUMATICS surveys readers for their experiences and opinions in fluid power design.

• ***What improvements would you like to see in fluid power components?***

More Catalog Information

I have difficulty in comparing equipment of manufacturers because of the many different ways their catalogs are made up. Quite often good equipment is passed by because full information is not contained in the catalog. Then lower grade, but adequate, equipment is specified because of the time required to obtain full information on more desirable items.

J. E. FRENCH
Development Engineer
General Atomic Corp.
San Diego, California

High Speed Hydraulic Press

We have been interested in designing and manufacturing a 200-ton hydraulic press with a platen size of 33" x 47" that would operate at 80 strokes a minute for high production of corrugated boxes.

To date we have found such a design impractical.

L. REMMINGTON
Works Manager
Thomson National Press Co.
Franklin, Massachusetts

Hydraulically Operated Valves

We are limited by the lack of available equipment to convert our 4" and larger rising stem gate valves to hydraulic opening and closing. Undoubtedly some firm or firms manufacture all of the necessary components for this conversion. We have had conversion components locally made to con-

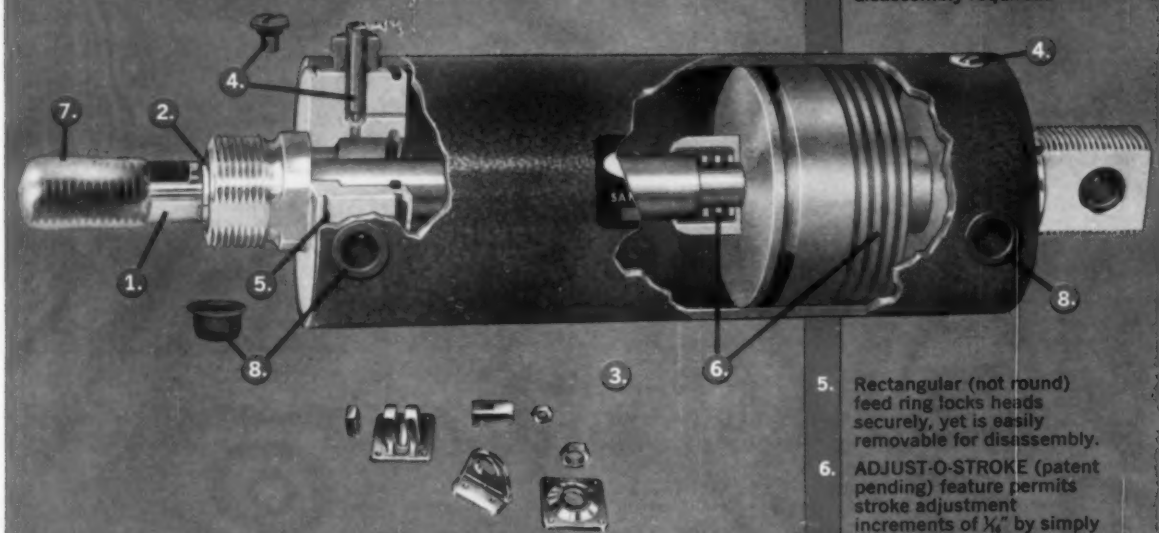
Continued on page 20

another **NEW PRODUCT** *from...*

Modernair
® Trademark

check these important features...

SERIES R ECONOMAIR CYLINDER



1. Hard chrome-plated steel piston rod with rod flats.*
2. Metallic rod wiper, with automatic wear compensation.
3. Interchangeable mountings.
4. Cushions "now or later"—to add cushions, simply remove plug and insert cushion needle valve; **no cylinder disassembly required.***
5. Rectangular (not round) feed ring locks heads securely, yet is easily removable for disassembly.
6. ADJUST-O-STROKE (patent pending) feature permits stroke adjustment increments of ¼" by simply adding or removing spacers; total adjustment is ⅛".*
7. Strippable plastic (government approved) protects all threads during shipment or storage.
8. Plastic plugs protect ports until used.

*Not available on 1⅛" bore sizes which have stainless steel rods, fixed cushions.

New Series R Economair cylinders are available for immediate delivery in 1⅛", 1½", 2", 3" and 4" bore sizes. See your phone book yellow pages for your nearest Modernair dealer, or write us for catalog, price list.

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MEMBER NATIONAL FLUID POWER ASSOCIATION

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Cellulube 220 was chosen for this hydraulic press when it was installed at North American in 1956. At that time it was used for form-die quenching of hot, fully expanded titanium parts at 1000°F.

...and since 1959, this same press has been used to form brazed stainless steel "honeycomb" panels for the B-70 bomber. The panels are pressure-quenched at 1700°F. Cellulubes are still safely on the job.

at 1000°F...or 1700°F...Cellulubes

FM Factory Mutual-Approved
(Cellulubes 150 and 220)

Bureau of Mines—Approved #30-2

Celanese Chemical Company, Dept. 588-K, 522 Fifth Avenue, New York 36, N. Y.
Data on Cellulubes, please!

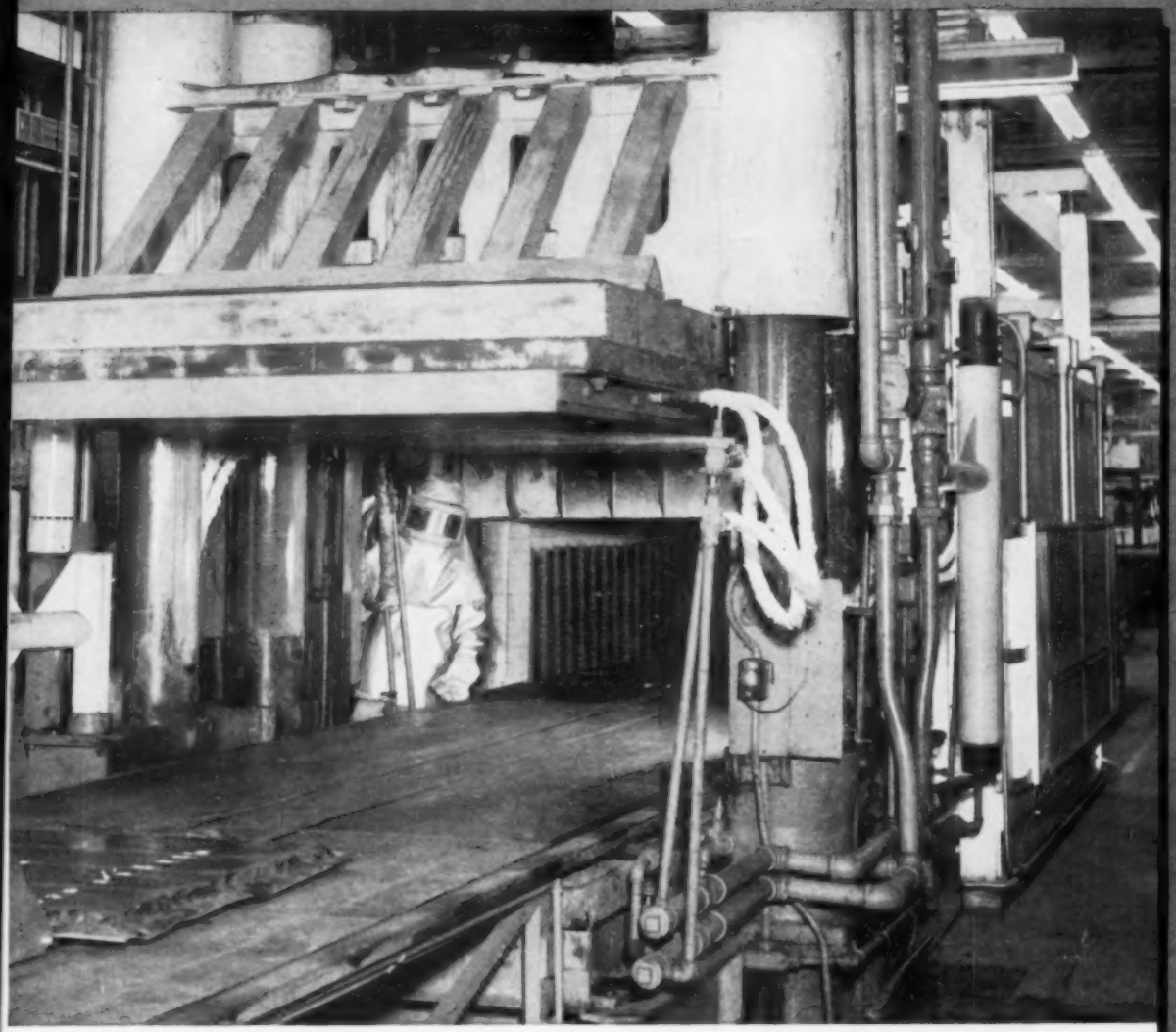
Name_____

Company_____

Address_____

City_____ Zone_____ State_____

Application I have in mind_____



guard safety at North American

In high-temperature press-forming operations like these, hydraulic line breaks could be a serious fire hazard. North American Aviation assures maximum protection for personnel and equipment by using Celanese Cellulubes—the *safe* hydraulic fluids. It's the best way to take the worry out of high-temperature production.

Perhaps you should be using Cellulubes, too! In addition to their safety advantages, Celiulubes provide overall protection against wear comparable to that of premium petroleum oils. There are no foaming problems, no additives to deposit in the system. Vapor pressure is extremely low; vapor losses negligible. And Cellulubes come in your choice of six viscosity ranges.

Mail the coupon for details, Celanese Chemical Company, 522 Fifth Avenue, New York 36, New York.

Celanese® Cellulube®

Cellulubes... Celanese fire-resistant functional fluids

CHEMICALS

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Circle **28** on Reader Service Card

CELANESE CELLULUBES

HIGH TEMPERATURE HIGH PRESSURE EQUIPMENT FOR THE HYDRAULICS INDUSTRY

VALVES

A complete range of standard tubing, valves and fittings with pressure ratings from 4,000 to 100,000 p.s.i. Special valves for high temperature and other extreme or unusual applications also are available.

PRESSURE VESSELS

Standard and special designs for laboratory, pilot plant and production operations—pressures to 100,000 p.s.i. Stirred and magnetically agitated autoclaves from 300 c.c. to 500 gallons.

PACKAGE SYSTEMS

Designed and built to your needs: package systems, complete with reactors, pumps, compressors, valving and instrumentation, for diffusion bonding, isostatic pressing, shock tube and corrosion testing.

Bulletin 1157 will acquaint you with our capabilities and service in the design and manufacture of pressure equipment. A copy is yours for the asking.

AUTOCLAVE ENGINEERS
INCORPORATED
2935 West 22nd Street • Erie, Pennsylvania

Circle 13 on Reader Service Card

FORUM

vert some of our 12" and 18" gate valves, but the cost is prohibitive.

Converting valves from hand to hydraulic manipulation will improve our equipment by speeding up opening and closing and by allowing us to make better use of our manpower. It will not, in this instance, eliminate man power.

J. R. LOWRIE
Factory Superintendent
Lihue Plantation Co., Ltd.
Lihue, Kauai, Hawaii

Military Numbers Needed

At present we are not limited by availability of fluid power components. However we do find it difficult at times to correlate the various commercial products, models, model numbers, etc. with military procurement nomenclature, ordnance part numbers for standard commercial products, etc.

We do quite a lot of bidding on army ordnance procurement requests and find that most hydraulic component parts manufacturers do not list MS, AN, or Ordnance Numbers for their products. Some manufacturers do list military numbers in conjunction with their own parts numbers, but not nearly enough of them are doing it yet to make it easier to locate the component parts.

LESTER I. LOVELL
Project Engineer
Todd Shipyards Corp.
Products Div.
Houston, Texas

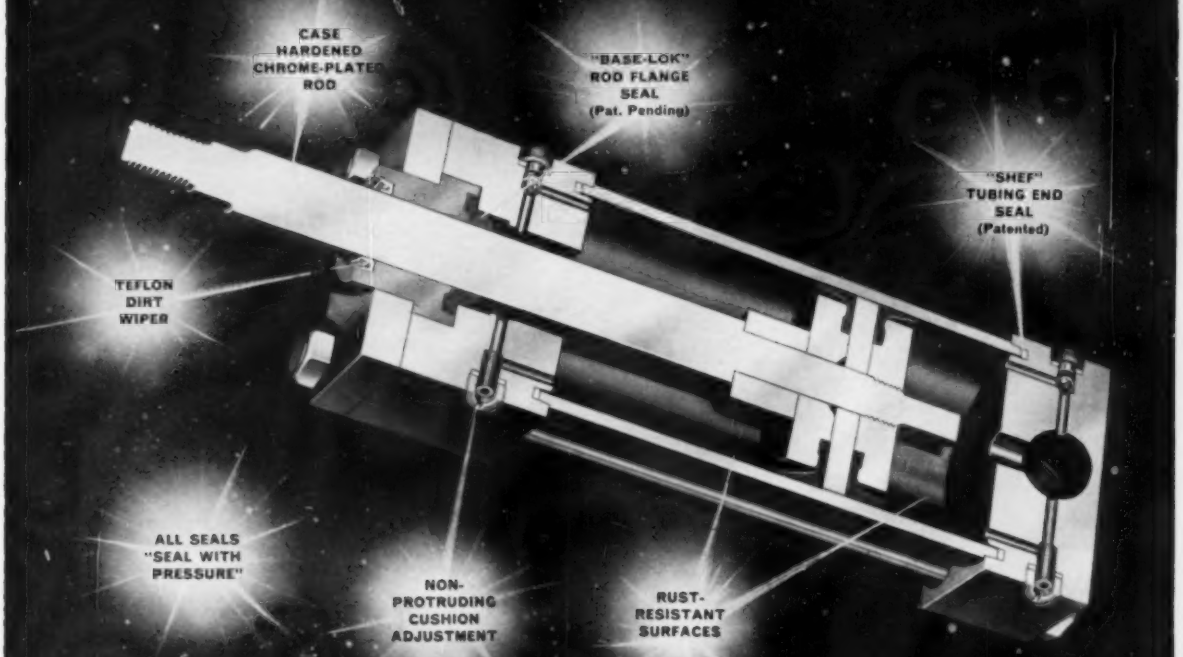
Manufacturers Assist Designer

In designing the major portion of our hydraulically-operated, motor assembly machines, I find that the presently available fluid power components more than fill the bill. Also, with the very competent assistance that the various manufacturers give us on the proper application of their components, we have very little difficulty with our hydraulic systems.

OSCAR ANDREWS
Machine Designer
Franklin Electric Co., Inc.
Bluffton, Indiana

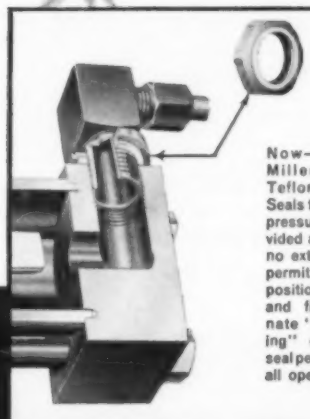
▼▼▼

Stellar RELIABILITY and ECONOMY


CASE HARDENED CHROME-PLATED ROD
"BASE-LOK" ROD FLANGE SEAL (Pat. Pending)
"SHEF" TUBING END SEAL (Patented)
TEFLON DIRT WIPER
ALL SEALS "SEAL WITH PRESSURE"
NON-PROTRUDING CUSHION ADJUSTMENT
RUST-RESISTANT SURFACES

Miller AIR CYLINDERS

PORT SEALS



Now—with every Miller Cylinder—Teflon-sealed Port Seals that "Seal with pressure" are provided as standard at no extra cost. They permit much faster positioning of lines and fittings, eliminate "overtightening" damage, and seal perfectly against all operating media.

Here are eight more reasons why Miller Air Cylinders continue to be the most economical and reliable cylinders that money can buy. These stellar features—including the new port seals—are standard Miller construction—yours at no extra cost. Thus, they provide appreciable savings in original investment—*particularly for those who insist on "J. I. C." quality throughout.* Savings in operating costs are even greater, because these features are proven assurance of longer cylinder life, greater efficiency, reduced maintenance and downtime.

Specify "Miller" for greater reliability and economy! Write for bulletin.

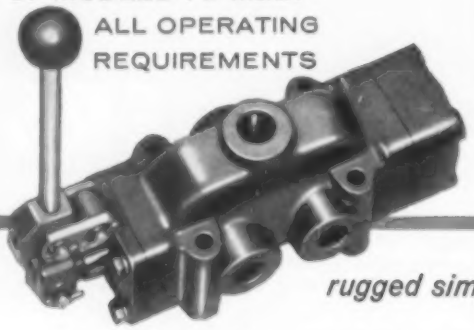
R

MILLER FLUID POWER
DIVISION OF FLICK-REEDY CORPORATION
7N017 York Road, Bensenville, Illinois
AIR AND HYDRAULIC CYLINDERS • ACCUMULATORS
COUNTERBALANCE CYLINDERS • BOOSTERS

ADEL...offers you *single source* responsibility

for precision hydraulic control valves

4-WAY SELECTOR VALVES IN A VARIETY OF MODELS TO MEET ALL OPERATING REQUIREMENTS



a complete line for every application

GENERAL SPECIFICATIONS

FLUID: Oil, for hydraulic use only.
PRESSURE: 1500 psi maximum.
FLOW: 3 to 28 gpm.
PORT SIZES: ¼ to 1" pipe size.
MATERIAL: Slides and spools—hardened steel; bodies—gray iron castings.
Various forms of return springs or detents for slide positioning.

MODELS

Lever-Operated For Hand Control. Stem-Operated For Remote Manual Control.

Solenoid-Operated in Various DC and AC Voltages.

Pilot-Operated For Remote Hydraulic Control.

rugged simplicity for efficient, long, reliable service life

These compact, 4-way selector valves are used for control of double acting, or single acting cylinders. Simple spool-type construction provides a wide variety of porting arrangements for either open-center or closed-center hydraulic systems.

The Valves With Maximum Operating Efficiency Over The Years
***Let ADEL be your* single-source *for* precision hydraulic equipment**
Write for valve brochure containing complete specifications.

Designers & Manufacturers of Industrial & Marine Hydraulic Control Equipment

Reliability
ADEL PRODUCTS DIVISION

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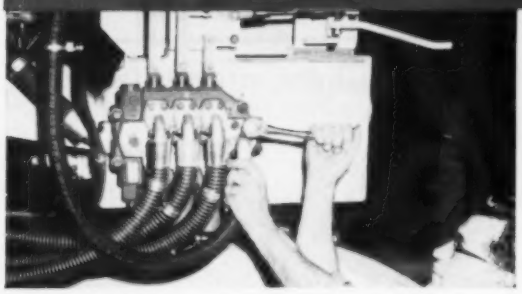
A DIVISION OF GENERAL METALS CORPORATION

A SUBSIDIARY OF TRANSAMERICA CORPORATION

New Aeroquip Fitting Wins Place on Major Equipment



IRON MIKE Fittings are installed on the production line in the plant of a major construction equipment manufacturer.

Checked after lengthy field service, Aeroquip Hose Lines with IRON MIKE Fittings proved they could withstand the most punishing tests.

IRON MIKE Fittings and 1509 Synthetic Wire Braid Hose are recommended for hydraulic and pneumatic systems up to 2250 psi., as well as fuel and lube lines.

IRON MIKE T.M.

NEW, LOW-COST REUSABLE FITTING PROVEN DEPENDABLE

Exhaustive field testing proved to one major equipment manufacturer that Aeroquip's new IRON MIKE Fitting meets their requirements best for high pressure hose lines. It combines the rugged dependability and field service advantages of a reusable fitting with the low initial cost of a non-reusable fitting.

This manufacturer is now standardizing on Aeroquip High Pressure Hose and IRON MIKE Fittings for heavy-duty hydraulic lines on all of its equipment.

IRON MIKE Fittings are now available for hose sizes from ¾" to 2" I. D., in ten standard end styles to meet a wide range of equipment applications. For full details, return the coupon below.

PATENT APPLIED FOR

Aeroquip

AEROQUIP CORPORATION • JACKSON, MICHIGAN
INDUSTRIAL DIVISION
INDUSTRIAL PLANTS: VAN WERT, OHIO; BURBANK, CALIFORNIA; DALLAS, TEXAS; PORTLAND, OREGON; CRANBURY, NEW JERSEY
In Canada: Aeroquip (Canada) Ltd., Toronto 19, Ontario
In Germany: Aeroquip G.m.b.H., Baden Baden-Oos
AEROQUIP PRODUCTS ARE PROTECTED BY PATENTS IN U.S.A., CANADA AND ABROAD

Aeroquip Corporation, Jackson, Michigan HP-11
Please send me Bulletin 651 on new IRON MIKE Fittings.

Name_____

Title_____

Company_____

Address_____

City_____ Zone_____ State_____

FLUID POWER AT WORK

keeping up with design, application, methods

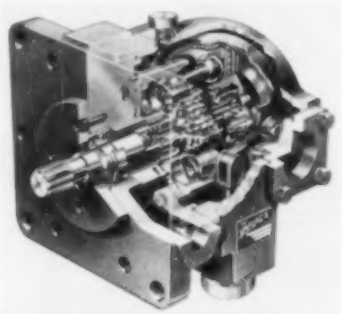
Hydrostatic Transmission Has 2- or 4-Wheel Drive

FORT BELVOIR—A new hydrostatic transmission was recently demonstrated at Fort Belvoir Engineer Proving Grounds by Gar Wood Industries, Wayne, Michigan. The transmission was mounted on an earthmoving scraper, but is adaptable to any heavy duty vehicle.

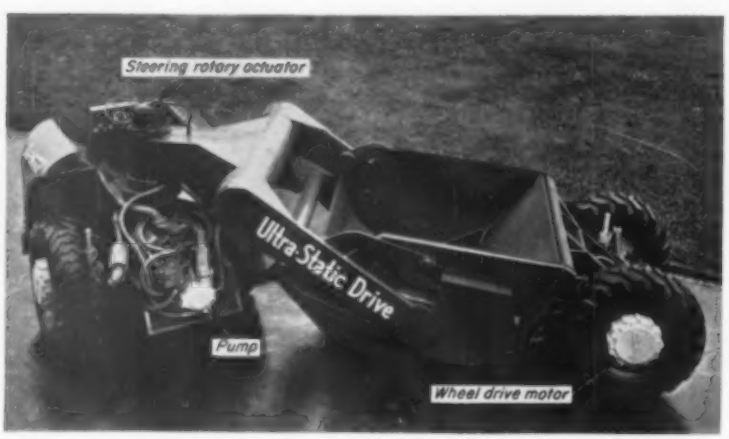
Conventional hydrostatic drive transmissions have a positive displacement pump driving a positive displacement motor. By varying pump and motor sizes, a combination of varied speed and torque output can be obtained in relation to speed and torque input. Speeds and torques are infinitely variable within the ranges of pump and motors.

In Gar Wood's Ultra-Static drive, a variable displacement axial piston pump mounted at the rear of the engine supplies oil to the drive motors mounted in the wheels. Each wheel motor is coupled to a differential planetary with a 13¼ to 1 reduction. The main pump delivers 250 gpm at 2500 rpm, with a maximum pressure of 2500 psi. Motors displace 23½ cu in./revolution.

The design and construction of pump and motors are similar. Each has a rotating group or assembly consisting of nine axial pistons connected to a ball and socket arrangement. To obtain variable volume, the tilt box at the rear of the pump is varied between zero and its maximum tilt angle of 20 degrees. This rotating group is identical for pump and motor, the only variation being in the control of the variable volume motor. Aluminum pumps or motors weigh 160 lbs.



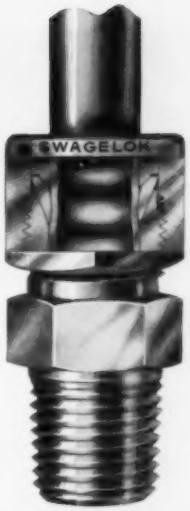
VARIABLE VOLUME PUMP has nine axial pistons connected to a ball and socket arrangement. Delivery is varied by changing angle of tilt box.



MACHINE IS STEERED by directing oil to the rotary actuator just at the rear of the driver. Power for steering circuit is provided by 56 gpm variable delivery pump.

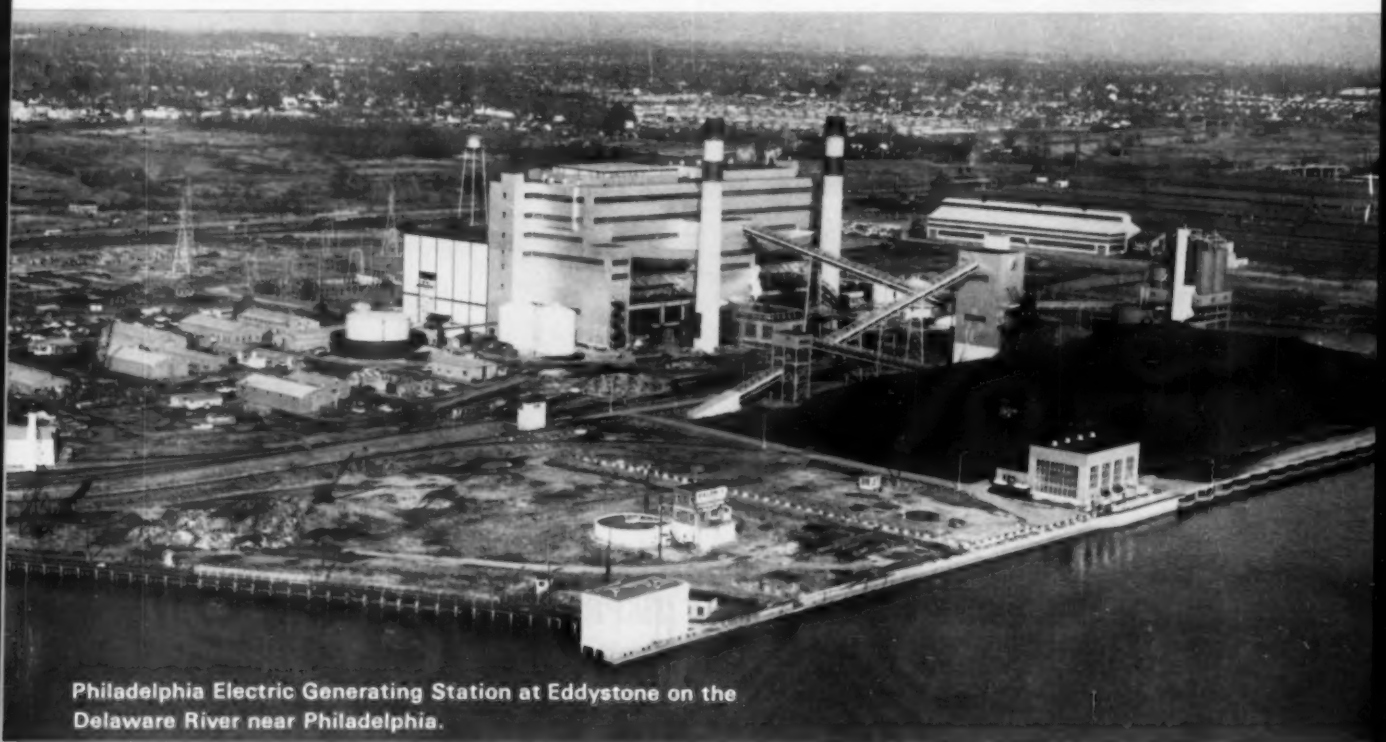
The hydrostatic transmission has two or four-wheel drive either of which can be selected while the vehicle is moving. Maximum speed reached during test runs is 30 mph empty, and 22 mph loaded. Maximum test drawbar pull is 18,000 lbs. Controls consist of a forward, neutral, and reverse lever; a throttle control for constant engine speed; an accelerator for variable engine speed, and a brake valve. Power steering is obtained with a power steering cartridge using a variable volume controlled axial piston pump. This pump delivers approximately 56 gpm at governed engine speed to a rotary actuator located behind the driver. ▼▼▼

WORLD'S MOST EFFICIENT POWER STATION SPECIFIES MOST EFFICIENT TUBE FITTINGS



Swagelok®

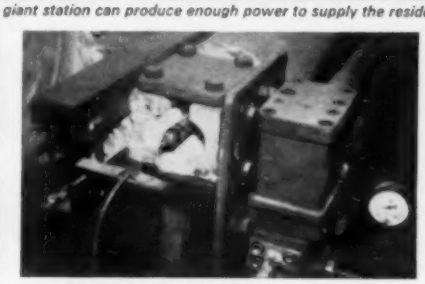
Philadelphia Electric Company's new Eddystone Station is an engineering achievement of which Americans can be proud. Representing a major breakthrough in the power industry, the Eddystone Electric Generating Station was designed as the world's most efficient power plant. This improvement in efficiency has been achieved by generating steam at a supercritical pressure of 5000 pounds per square inch and a temperature of 1200° F.



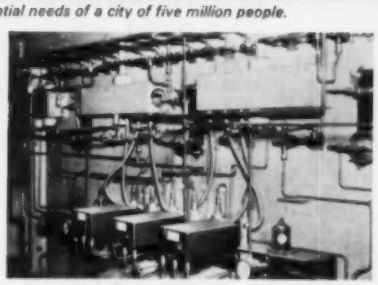
Philadelphia Electric Generating Station at Eddystone on the Delaware River near Philadelphia.

Housing two 325,000 kilowatt turbine generators, this giant station can produce enough power to supply the residential needs of a city of five million people.

Control Center for Eddystone Plant Operation.



Swagelok Tube Fitting used as a thermocouple connector on main steam header #1 for boiler control. Operating conditions: Steam at 5000 psig — 1200° F.



Swagelok Tube Fittings used in control systems of supercritical pressure boiler.

Swagelok® **TUBE FITTINGS**

Crawford Fitting Company, 884 East 140th Street, Cleveland 10, Ohio • Crawford Fittings (Canada) Ltd., Niagara Falls, Ontario, Canada

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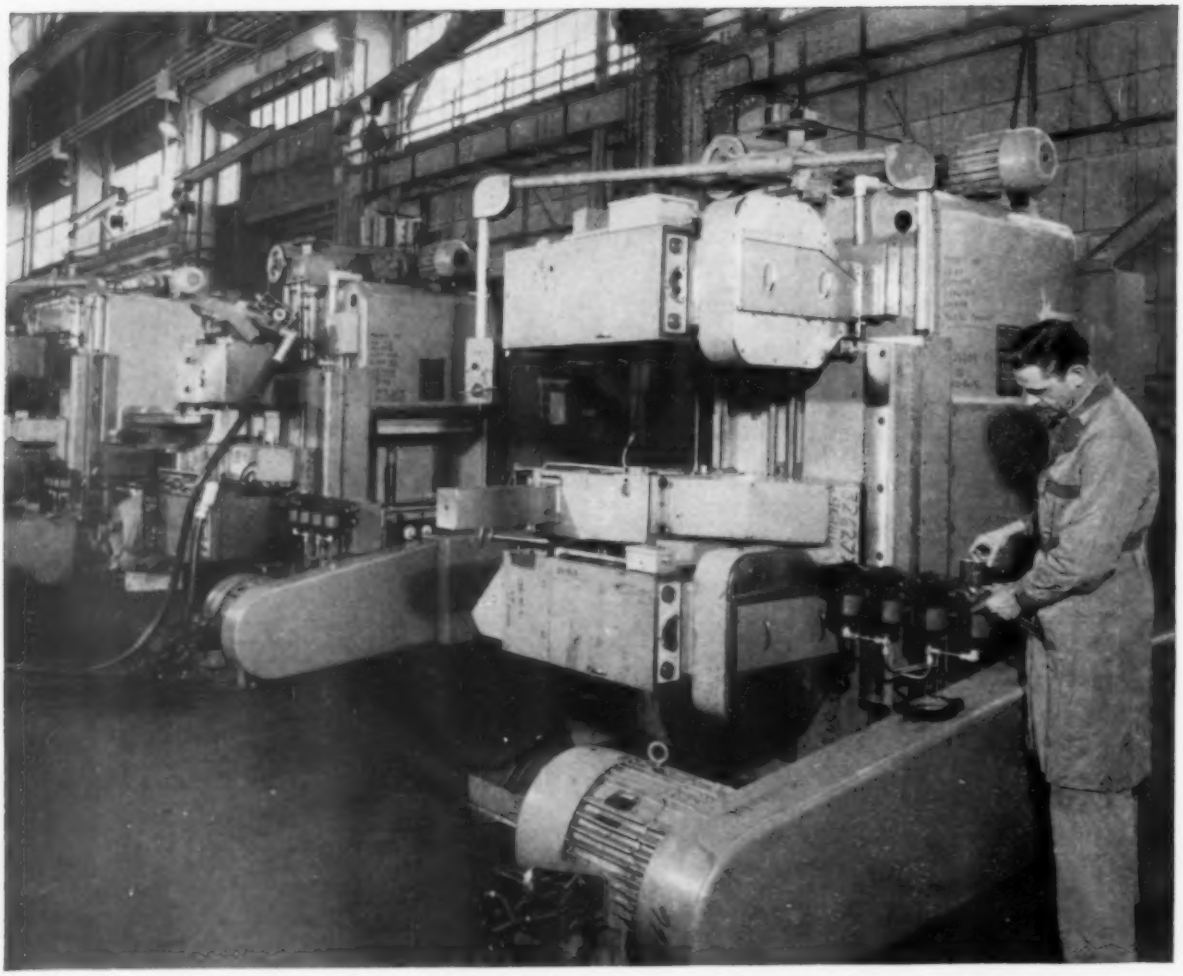

New 10-micron filtration for both hydraulic and lubricating systems of re-designed Bullard dynatrol vertical turret lathe. Made of resin-impregnated, waterproof paper, Purolator Micronic filters withstand a differential pressure of 75 psi . . . temperatures up to 275°F.

PUROLATOR MICRONIC® FILTERS IMPROVE FILTER EFFICIENCY 270% ON NEW BULLARD COMPANY TURRET LATHE AND BORING MILL

Ten micron filtration assures maximum operating efficiency and long equipment life. "Tolerances are a lot closer on our new vertical turret lathe and horizontal boring mill," says Bill Glynn, Project Engineer for Bullard. "Parts like the new hydro mesh feed brackets and solenoid valves would wear out fast if we used the old steel filters which only filter down to 37 microns."

Used for both hydraulic and lubricating systems. "We upped filtration efficiency some 270% by installing Purolator Micronic filters on both hydraulic and lubricating systems.

"With this new 10-micron full-flow filtration we should get the best possible performance from our new equipment."

Element replaced only every 1000 hours. "Replacing the Micronic filter element takes only a minute," Glynn goes on to say. "And since a new one is needed only every 125 8-hour working days or so, we feel these new filters will cut downtime and production costs, too."

Ideal for precisely-finished new equipment. Reliable, full-flow filtration down to 10 microns means that Purolator Micronic filters give maximum protection to precisely-finished new equipment. These same filters can also mean improved performance and longer service life from existing equipment.

For full information, contact your nearest Purolator Sales Office, or write: Purolator Products, Inc., Rahway, N. J.

Filtration For Every Known Fluid

PUROLATOR
PRODUCTS, INC.

RAHWAY, NEW JERSEY AND TORONTO, CANADA

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Circle **104** →

CARTER CARBURETOR CONVERTS ALL 50 DIE-CASTING MACHINES TO PYDRAUL® A-200

Preventive maintenance with PYDRAUL

Carter Carburetor, a Division of ACF Industries, Inc., with a 10-year preventive maintenance program, *proves* economy of fire-resistant PYDRAUL in reducing downtime.

In identical die-casting machines, there were 62 pump failures per year with water-glycol fluid and *only 3* with PYDRAUL.

Carter action → 100% switch to Pydraul A-200.

COMPARE!

	PYDRAUL	Water-glycol fluid
Lubricity	Excellent	Fair
Thermal Stability	Excellent	Poor
Vapor Pressure	Very low	High
Fire Resistance	Excellent	Excellent *(provided water has not evaporated)*

Investigate how PYDRAUL can reduce *your* maintenance problems and guarantee safety in your operations. Mail the handy coupon today!

PYDRAUL safeguards production and personnel using die-casting machines • hydraulic presses • furnace tilters • mold casters • stampers • extrusion presses • ingot loaders • injection molding machines • forging presses • **Over 500 million machine-hours proves PYDRAUL performance.**

Monsanto®

Monsanto Chemical Company
Organic Chemicals Division
Industrial Fluids Dept. 4446U
St. Louis 66, Missouri

Please send me these new bulletins:

☐ "Know Your Fire Hazards"

☐ "Preventive Maintenance in Fire-Resistant Hydraulics"

NAME..... *TITLE*.....

COMPANY.....

STREET.....

CITY..... *ZONE*..... *STATE*.....

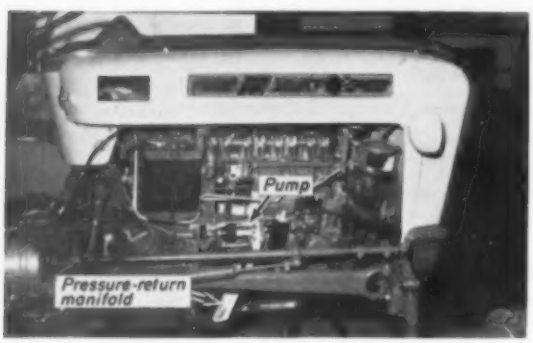
FLUID POWER AT WORK

. . at the SAE Heavy Duty Vehicle Show

Hydraulic displays exhibited at the recent SAE show in Milwaukee emphasized flow metering and control. Engineers manned the controls to get the feel of the flow metering components.

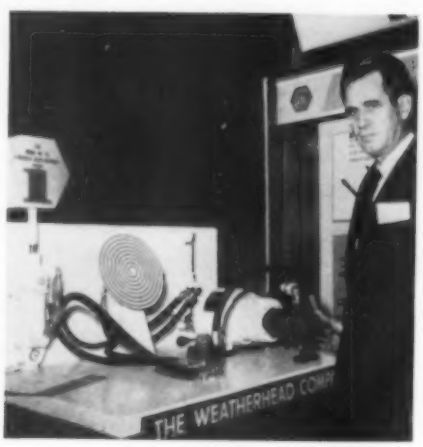
POWER STEERING unit manufactured by Char-Lynn Co. eliminates mechanical linkages between steering wheel and axle. Orbitrol is mounted on steering shaft, and provides remote servo rotary control. Capacity range is 2.5 to 6 gpm; maximum operating pressure is 1200 psi.

PLASTIC COMPONENTS in this system exhibited by Wooster Div., Borg Warner Corp. let engineers watch flow path of colored oil. Metering notches in valve give fine, easy inching control.



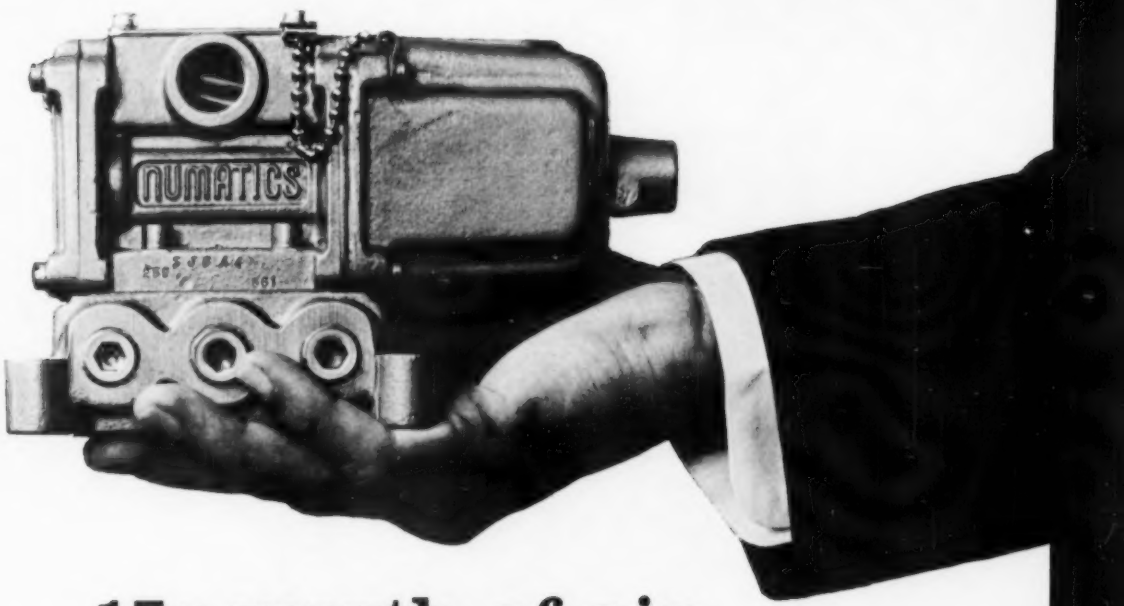
TRACTOR MODEL made by Ford Motor Company shows construction of axial piston pump which is connected to cast, pressure-return manifold. Pump delivers 4 gpm at 2000 psi, 2000 rpm and supplies the power to actuate rockshaft-mounted implements.

VARIABLE DELIVERY PUMP recently introduced by the Weatherhead Co. is pressure-compensated and supplies 0 to 9 gpm to actuators at maximum pressure of 3000 psi. Selector valve, center, can also be used as flow control valve.



THREE FLOW DIVIDERS provide individual controls to their respective actuators. The flow dividers manufactured by Fawick Hydraulic-Electronic Div., let the operator change the speed of any motor without affecting the speed of the others.

this air valve leaks



...15c worth of air

...in one year!

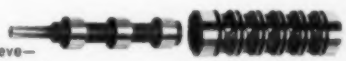
This valve leaks at a rate of about .003 C.F.M. or 15c worth of air in a year. During its unlimited service life the loss will drop to even less. Numatics valves *improve* with service. Unlike poppet valves, there is no blow by from intake to exhaust as the valve shifts.

So what?

You pay 15c a year to get rid of working resilient seals and the inevitable down-time that results from seal failure in an air valve, because the Numatics valve *has no working seals.* Its stainless steel spool and sleeve, fitted to *millionths* of an inch, needs no working seals!

Run it on any standard lubricant, or run it dry, the Numatics valve is the most reliable air valve on the market!

Buy some.



The lapped spool and sleeve—
it works, and works, and works!

NUMATICS, Inc.

Highland, Michigan

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WEATHERHEAD FLUID POWER PRODUCTS...SYSTEM ENGINEERED

NEW! WEATHERHEAD VARIABLE DISPLACEMENT HYDRAULIC PUMP

UNMATCHED... ANYWHERE !

The new **W07** pump gives economy and performance advantages unmatched in high pressure, fluid power system applications. No other mass-produced, variable displacement hydraulic pump can now offer *all* these benefits:

INSTANT RESPONSE . . . hydraulically balanced, direct cylinder block actuation at lower power level without linkages.

PEAK EFFICIENCY . . . only two rotating parts; side loads on pistons minimized.

CONTROL VERSATILITY . . . pumping forces virtually eliminated from the displacement changing mechanism.

HIGH TEMPERATURE CAPABILITY . . . unique piston actuation permits fluids of low lubricity.

PUMP ECONOMY . . . size and weight are adaptable to a variety of applications; top reliability assured with no selective fits.

Pressure compensation control is provided as standard and integral part of the pump in adjustable pressure ranges from 250 psi to 3000 psi.

The W07 pump incorporates J.I.C., S.A.E. and A.N.D. design requirements for industrial and mobile applications; meets stringent requirements of military specifications. Spline or keyway shafts are available.

Application and design data are available from your nearby Weatherhead sales engineer. Direct inquiries to:

THE WEATHERHEAD COMPANY
HYDRAULICS AND PNEUMATICS
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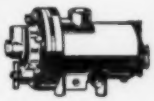
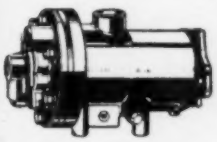
WEATHERHEAD
HYDRAULIC POWER
Components

VARIABLE DISPLACEMENT PUMPS

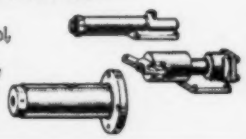




Meet J.I.C., S.A.E., and M.S. standards. Pressures to 3000 psi

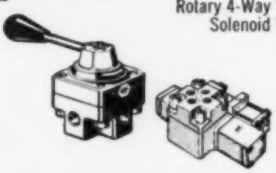
PUMP CONTROLS

Pressure Control, Automatic (Constant) Flow Control, Manual Displacement Control



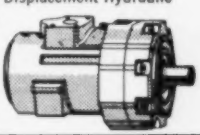
DIRECTIONAL CONTROLS

Rotary 4-Way Valves
Solenoid Valves



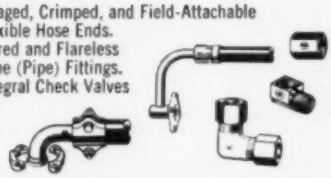
HYDRAULIC DRIVES

Fixed Displacement Hydraulic Motors; Reversible Variable Displacement Hydraulic Motors (Integrated Torque and Speed Control)



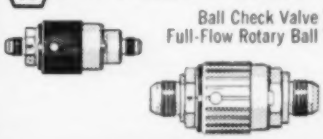
HIGH PRESSURE HOSE AND FITTINGS

Swaged, Crimped, and Field-Attachable Flexible Hose Ends.
Flared and Flareless Tube (Pipe) Fittings.
Integral Check Valves



SELF-SEALING COUPLINGS

Ball Check Valve Type
Full-Flow Rotary Ball Type



* to precisely fabricate parts, seals and components . . . from selected compounds and for specific applications ONLY!

Developing Silicone rubber compounds that embody properties to meet today's product requirements, is a Goshen specialty. GRC-engineered Silicone rubber parts, seals and components have no superior when it comes to resistance to chemicals, acids, extreme temperatures, moisture, weathering, oxidation, ozone and other factors that defeat organic rubbers. That's why they're in increasing demand in today's vital electronic, automotive, aero-space and other industries. Let us know *your* problem.

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FLUID POWER AT WORK

HYDRAULICALLY OPERATED tilting mechanism tips the rotating drum of this concrete mixer manufactured by the Erie Strayer Co., Erie, Pa. Instead of pivoting on a central axis as conventional tilting mixers do, this unit swings up and out over an eccentric path as it tilts. The 55 degree tilt angle makes it possible to produce and discharge extremely low slumps.

MINIATURE PUMP powers this combination tensile, compression, and guided bend testing machine, manufactured by Steel City Testing Machines, Inc., Detroit. Reservoir and pump are in base of tester. Capacity is 10,000 lb.

IN-LINE, PART-THROUGH TRANSFER MACHINE, produced by Buhr Machine Tool Co., Ann Arbor, machines aluminum transmission cases at the rate of 180 per hour. Work pieces are positioned and clamped automatically. The hydraulic system includes 29 pumps and the same number of tanks and filters. The hydraulic tank capacity is 1,080 gal and it has a 412 gal/min rating. Tubing throughout the machine stretches for over a mile in length. There are 148 hydraulic cylinders with 42 compensated flow control valves.

Expensive, time-consuming machining operations can often be reduced or eliminated by use of Republic ELECTRUNITE Special Smooth I. D. Hydraulic Cylinder Tubing.

Cold drawing through a ring die and over a highly polished mandrel enables "Special Smooth I. D." to meet exacting tolerances on the inside and outside diameters. This drawing operation also provides a dense surface finish and increases the mechanical properties of the steel.

Sizes range from 1" I. D. to 5⅜" I.D. with varying wall thickness limits, from .049" through .225" and heavier. I. D. tolerances range from ±.003" on the smaller sizes and lighter walls to ±.010" in the range from 4⅝" I.D. to 5⅜" I.D. Wall thickness tolerances are held as close as .0025" and in no case greater than ±.007". 50% closer than standard tolerances noted above are regularly supplied. All Republic Special Smooth I. D. Hydraulic Cylinder Tube is finished to a maximum surface smoothness microinch finish.

All Republic Special Smooth I.D. Hydraulic Cylinder Tubing is manufactured by the exclusive ELECTRUNITE process which welds without addition of filler metal. Tubing is then normalized in a controlled atmosphere furnace which recrystallizes the weld area, assuring a uniformly ductile tube with complete homogeneity of the tube wall.

Every tube is subjected to severe testing to insure suitable quality for the application and is rigidly inspected during manufacture and before shipment for proper surface and dimensional properties.

For full information on Republic ELECTRUNITE Special Smooth I. D. Hydraulic Cylinder Tubing and other Republic Hydraulic and Mechanical Tubing contact your Republic representative or write direct.

REPUBLIC STEEL

STEEL AND TUBES DIVISION

Cleveland 8, Ohio

REPUBLIC HAS THE FEEL FOR MODERN STEEL

Steel — Strong, Modern, Dependable

REPUBLIC STEEL CORPORATION
STEEL AND TUBES DIVISION • DEPT. A-2155-R
211 EAST 131st STREET • CLEVELAND 8, OHIO

Please send more information on Republic ELECTRUNITE® Special Smooth I.D. Hydraulic Cylinder Tubing

Name _____ Title _____

Firm _____

Address _____

City _____ Zone ____ State _____

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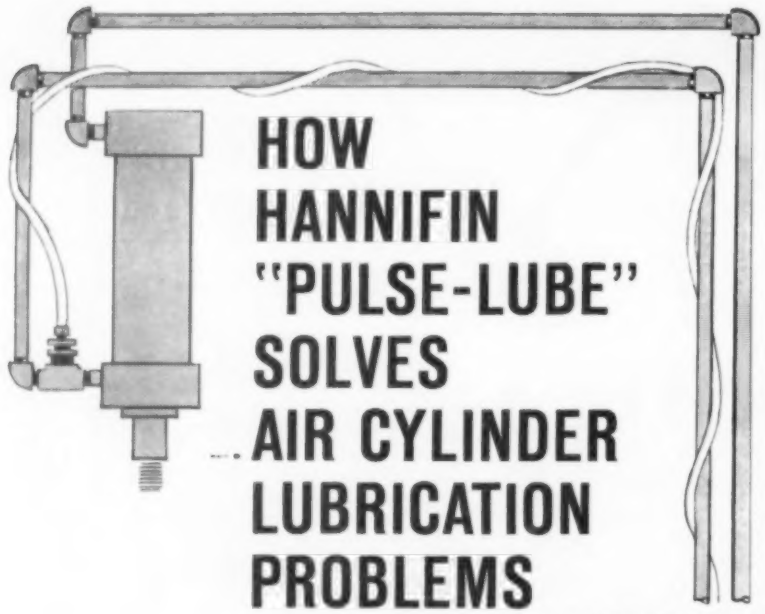
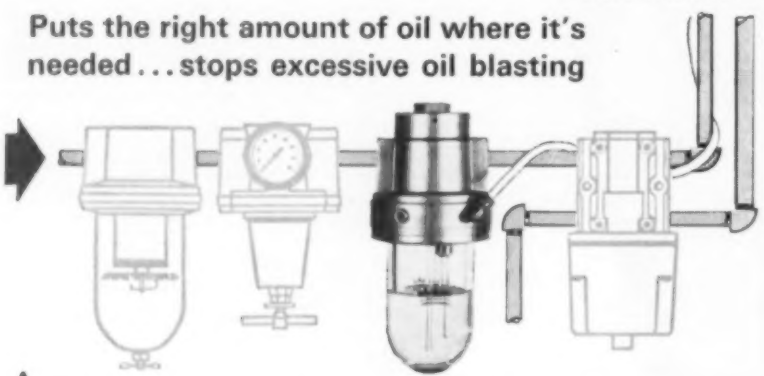


HOW HANNIFIN "PULSE-LUBE" SOLVES AIR CYLINDER LUBRICATION PROBLEMS ANYWHERE!

Puts the right amount of oil where it's needed... stops excessive oil blasting



AIRBORNE lubrication has long been the accepted way to get oil to air-operated equipment. But, let's face it, it does have its limitations.

If the cylinder is uphill from the lubricator, the air gets there, but the oil doesn't. The same thing happens "on the level" when it's a long way from your control valve to your cylinder. The oil gets only part way when the cylinder strokes, then gets blasted out the exhaust port of the valve on the return stroke. Cylinders that cycle rapidly on very short strokes, like the cylinders on gun welders, are particularly difficult to lubricate. Almost equally difficult are extremely slow stroke applications and installations where cycling is infrequent.

New "Pulse Lube" is Hannifin's answer to all these problems. One of these units, when added to a standard "Crown" lubricator as shown above, will deliver oil in a solid stream, apart from the main air flow. This oil can be piped any distance and put back into the air stream at any point. The amount of oil delivered is almost infinitely adjustable. As a matter of fact, as many as four Pulse Lube units can be installed in a single "Crown" lubricator and each may be adjusted differently.

In addition, the normal operation of the "Crown" lubricator need not be interfered with. In the typical installation shown above, for instance, the "Crown" lubricator would be adjusted very "lean" so as to supply just enough airborne oil to lubricate the valve. Meanwhile, the Pulse Lube unit is set to supply the exact amount of oil the cylinder needs, without wasting any oil at the valve exhaust port, so it pays for itself in the oil it saves.

Want to know more? Your Parker-Hannifin Crown Line distributor or your nearest Parker-Hannifin field sales office will be happy to explain how "Pulse Lube" works. Prices, installed or in kit form, are most reasonable. 3448-PH

PARKER HANNIFIN CORPORATION

PARKER-HANNIFIN

HANNIFIN COMPANY DIVISION

545 South Wolf Road • Des Plaines, Illinois

PNEUMATIC AND HYDRAULIC SYSTEM COMPONENTS

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FLUID POWER AT WORK

Joins NFPA Staff

The National Fluid Power Association announces the appointment of Theodore Pearce to its staff. He was named a vice president, and will assist executive vice president Barrett Rogers in the management of the Association and services to its members.

Ted Pearce

Ted is a graduate of Atlantic Union College and Boston University. He was a radio engineering officer in the U.S. Army during World War II. Ted Pearce was director of college relations and extension services at Michigan College of Mining and Technology before assuming his present position.

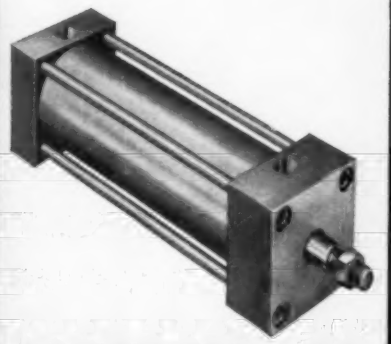
TRACING ATTACHMENT manufactured by the Man-Au-Cycle Corp., Brooklyn, is equipped with its own complete electrohydraulic power supply. The new attachment rough cuts and finishes in sequence, switching from rough to finish automatically. This all-hydraulic tracer cuts in both directions and can make a full ¾" diameter reduction in a single pass. Its maximum tracing length is 30", its stroke, 4".

NEW FROM HANNIFIN

A GENERAL PURPOSE AIR CYLINDER

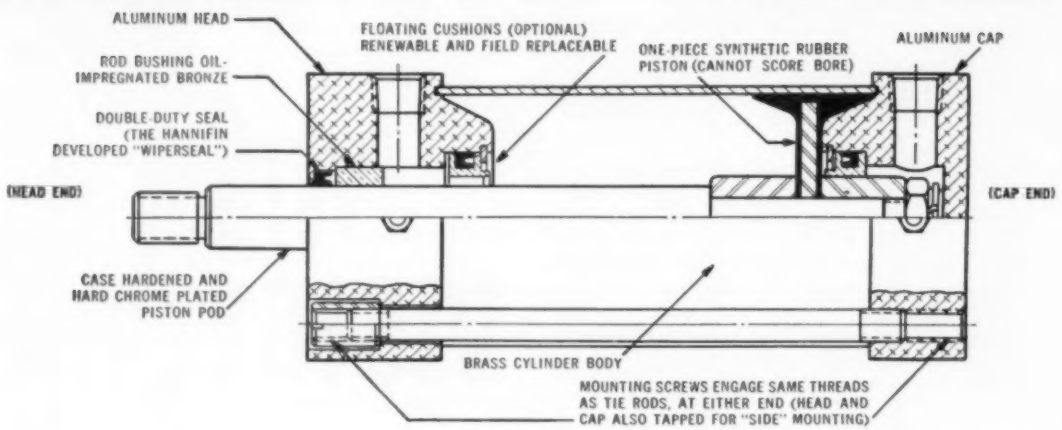
that gives you quality, low cost and mounting versatility

Hannifin announces a new design concept that gives you quality and economy in one package, the new Series "C" air power cylinder with . . .



- One compact basic design that provides side, cap end, or head end mounting without modification.
- Flange, foot or pivot mountings easily made with standard attachments.
- Rust proof construction — brass cylinder body, head and cap of aluminum.
- Cushions that do not change cylinder length — furnished as option or added in field with simple kit.
- An ingenious one-piece piston that cannot score the bore — of synthetic rubber, molded around a rugged steel disc.
- Piston rod both case hardened and hard chrome plated, polished to a fine finish for low friction and long seal life. Corrosion resistant.
- Rod bearing an oil impregnated bronze bushing. Minimizes friction.
- Gland seal the Hannifin-developed "Wiperseal" — both a rod wiper and an efficient dynamic seal. It keeps air in, dirt out.
- 5 bore sizes — 1¼", 1¾", 2½", 3⅛" and 4⅛". Stock strokes from 1" to 20" in 1" increments.

This new Hannifin cylinder design is the latest of the complete Hannifin line of air power cylinders. To help you choose the best Hannifin cylinder for your application, talk to your nearby Parker-Hannifin man. He knows cylinders!


ALUMINUM HEAD
FLOATING CUSHIONS (OPTIONAL) RENEWABLE AND FIELD REPLACEABLE
ONE-PIECE SYNTHETIC RUBBER PISTON (CANNOT SCORE BORE)
ALUMINUM CAP
ROD BUSHING OIL-IMPREGNATED BRONZE
DOUBLE-DUTY SEAL (THE HANNIFIN DEVELOPED "WIPERSEAL")
(HEAD END)
(CAP END)
CASE HARDENED AND HARD CHROME PLATED PISTON ROD
BRASS CYLINDER BODY
MOUNTING SCREWS ENGAGE SAME THREADS AS TIE RODS, AT EITHER END (HEAD AND CAP ALSO TAPPED FOR "SIDE" MOUNTING)

PARKER HANNIFIN CORPORATION

PARKER-HANNIFIN

HANNIFIN COMPANY DIVISION

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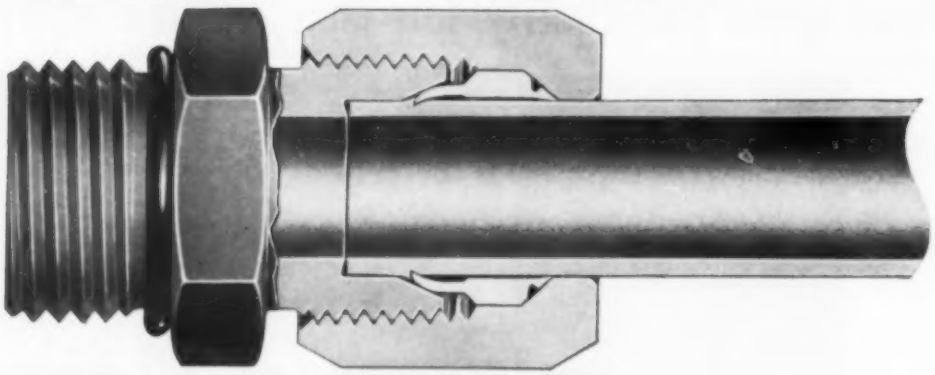
ONLY PARKER "FERULOK®" FLARELESS FITTINGS



GIVE YOU DOUBLE SEALING ACTION

Built for heavy duty but ideal for standard tubing as well, Ferulok's visible bite means a safe, leak-proof connection which will hold well beyond tube bursting pressures. You can see this bite, inspect it . . . and *know* that you have safe make-up.

The same wedging action that seals ferrule to tube and ferrule to fitting body also results in a firm grip on the tube by the "heel" of the ferrule, damping vibration and preventing stresses from concentrating at the line of bite.

Made in steel, stainless steel and Monel, Ferulok meets, and actually exceeds, the performance standards set by S.A.E., J.I.C., and A.S.M.E. It also has Underwriters' Approval and meets federal specification MIL-F-5506 and BuShips specification MIL-F-21467 for hydraulic and air systems in Naval ships.

Get the complete story from your Parker-Hannifin distributor. You'll get engineering help and prompt deliveries as well. Check the Yellow Pages, or if you prefer, write us direct.

...WITH THE VISIBLE BITE

PARKER-HANNIFIN

Parker FITTINGS AND HOSE DIVISION
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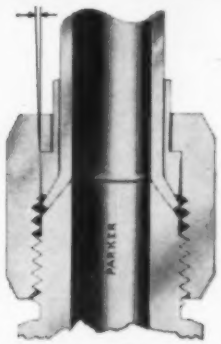
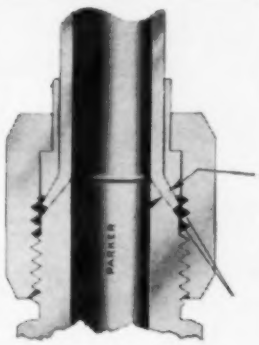
PARKER "TRIPLE-LOK®" 37° FLARE FITTINGS GIVE YOU THE QUALITY YOU NEED AT EVERY CRITICAL POINT!!!



A tiny Reverse Clearance Angle makes the Parker sleeve act as a lockwasher. Sleeve shoulder exerts pressure back against nut to prevent loosening from vibration, or from expansion and contraction.



The precise Differential Angle between sleeve and nose gives you perfect surface contact, maximum sealing and even distribution of make-up loads. It compensates for natural thinning of the flare.

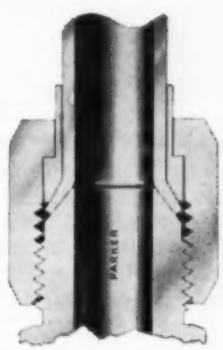
PARKER WORKMANSHIP PAYS OFF FOR YOU IN ASSEMBLY AND USE

The fact that Parker developed the original 37° flare fitting is only part of the story. At Parker today, infinite attention to detail is your assurance that you will get all the plus values inherent in the original Parker design.

Illustrated here are only four of the many critical points which Parker watches in making "Triple-lok," the 37° flare fittings that bear the Parker name. Tiny variations from the angles and clearances to which Parker craftsmen work can mean the difference between the maximum protection you get from the Parker product and something much less dependable. A Parker-Hannifin distributor is as near you as your telephone. Check the Yellow Pages, or write us direct.

Fittings shapes are machined from high-strength, one-piece forgings. No cast, extruded or brazed construction. The finer grain structure of forgings provides higher tensile strength and a greater elongation factor.

"Triple-lok" parts can be used repeatedly . . . are never deformed in make-up nor wedged on to tubing. Sleeve never rotates during assembly . . . no danger of wiping or scoring tube flare.



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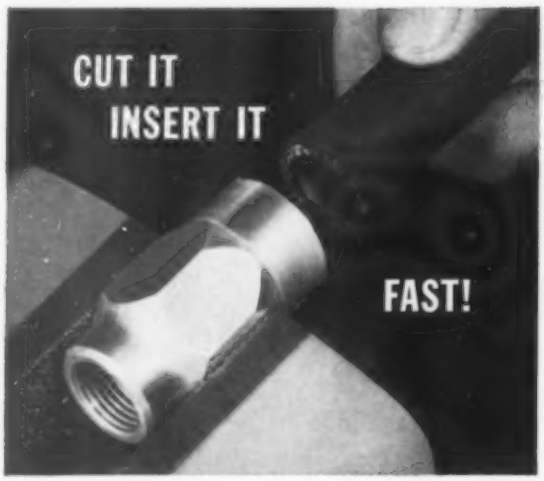
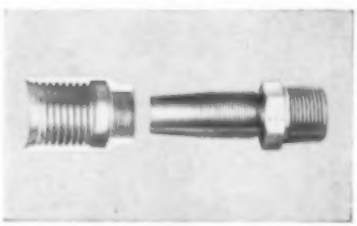
Save Hose Replacement Dollars

Using PARKER Fittings with PARKER Hose to make Replacement Assemblies Faster



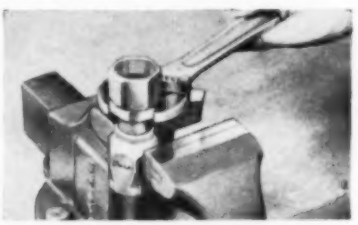
Installing Parker "Hoze-lok®" Fittings on Parker "No-Skive" Hose . . . NO SKIVING!

Installing ordinary fittings on ordinary rubber-covered hose . . . First, this messy skiving job.



Design of the "Hoze-lok" socket (left) makes the difference. The deep-tapped threads accept the **controlled thickness** rubber cover of Parker "No-Skive" Hose as they plow their way down to the wire braid of the hose. The rubber is displaced, not removed.

Just screw the hose in counter-clockwise, by hand. The rubber cover fills completely the space between each thread. It both protects and cushions the wire braid, eliminating a major cause of hose failure. A little Parker "Threadlube" is needed here.



The nipple, which is also the hose end fitting, screws in last, clockwise, in the usual way. You are now ready to make up the other end of your Parker No-Skive Hose Assembly. This method is not only faster; it gives you a better assembly. See next page.

You can install a Parker "Hoze-lok" Fitting on small-diameter Parker "No-Skive" Hose in 60 seconds. On 3/4" Parker hose, it takes 2 minutes or less. On very large sizes, allow 5 minutes per fitting. Hose replacement time is reduced to minutes the Parker No-Skive Way!

..*the* Parker No-Skive Way

Why Parker No-Skive Hose Assemblies Last Longer

BETTER PROTECTION FOR THE HOSE AT ITS POINT OF GREATEST STRESS

Most hose failures result from flexing. Ordinary hose, skived to the bare wire at the critical point where the first thread of the hose fitting bears directly on the wire braid, fails right there. As our picture shows, the leading thread of Parker "Hoze-lok" Fittings cannot reach the wire. The cushioning effect of the compressed rubber between the threads reduces the stress concentration at this point. Gripping by direct contact between the deep-tapped "Hoze-lok" threads and the wire braid occurs well within the fitting, where no flexing occurs.

Actual tests prove the effectiveness of this better design feature. Parker "Hoze-lok" assemblies on Parker "No-Skive" Hose rarely fail at the fitting, even when stressed to the burst point.

HOW PARKER DEVELOPED A BETTER HOSE TO MAKE THESE SAVINGS POSSIBLE

Parker "Hoze-lok" Fittings can be used with any hose, but you still have to skive ordinary rubber-covered hose, even with "Hoze-lok" fittings. Parker "No-Skive" Hose, however, is made to rigid specifications that limit and *control* the thickness of the cover to the exact amount of rubber that the corresponding size of "Hoze-lok" fitting will accept, when attached without skiving.

In all other characteristics, from the inner liner to the OD of the outermost wire braid, Parker "No-Skive" Hose conforms to S.A.E. specifications. In addition, because only a better grade of rubber compound can be extruded to Parker's exacting *controlled thickness* specification, the increased resistance to abrasion of the Parker "No-Skive" rubber cover results in a better hose.

Parker FITTINGS AND HOSE DIVISION

17325 Euclid Avenue • Cleveland 12, Ohio

PNEUMATIC AND HYDRAULIC SYSTEM COMPONENTS

ARRANGE NOW FOR A PARKER NO-SKIVE DEMONSTRATION IN YOUR OWN PLANT OR OFFICE

Gentlemen: We would like to see the Parker No-Skive Way to make up replacement hose assemblies demonstrated, without any obligation on our part, of course.

Please ask your salesman or nearest "Hoze-lok" distributor to get in touch with me:

Name_____

Title, Department or Division _____

Company_____

Address_____

City_____ Zone_____ State_____

We use hose for_____

3079-PH

LET'S TALK MANIFOLD FACTS!

The advantages of (Almo) manifolds as opposed to other manifolds are many. Their unique design offers complete flexibility in the mounting of take-offs and valves. Thus an Almo manifold is more adaptable to your requirements. Here are 3 features that definitely effect performance. weight and size.

ALMO* HYDRAULIC MANIFOLDS

1. Flow lines are short as possible with no corners or sharp recesses to collect dirt and obstruct flow.

2. Method of construction permits better utilization of area, smaller overall dimensions and fewer complications while maintaining correct channel dimensions and constant operating pressures. PSI capacity is a built-in quality.

3. Rectangular cross section of flow lines makes possible thinner overall construction and less weight than in comparable manifolds.

WEIGH THESE FACTS!

Let us work with you in improving your product. Write for brochure.

ENGINEERING RECOMMENDATIONS

*"THE UNIQUE FLUID CIRCUIT"

ALMO
MANIFOLD & TOOL CO.
11472 KALTZ / CENTERLINE, MICH.

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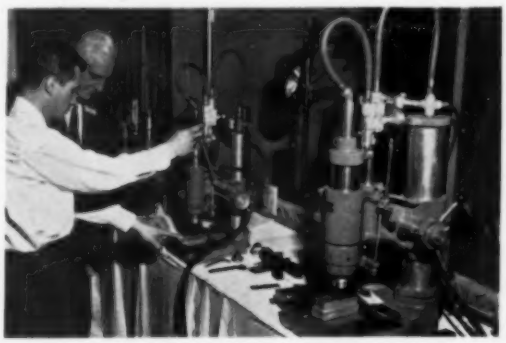
FLUID POWER AT WORK

Western Metal Exposition

Hydraulic and pneumatic power was dominant in keeping things moving at the Western Metals Exposition in Los Angeles.



HYDRAULIC IMPACT MACHINES for bench stamping, staking, swaging, riveting, and impression marking is the product of Heidrich-Norse Co., Los Angeles.

HYDRAULICALLY OPERATED precision tracing head made by True-Trace, El Monte, Calif., is shown mounted on big turning mill.

MISSILES INDUSTRY testing machine relies on responsiveness of fluid power for complex automatic programming of stresses delivered by hydraulic cylinder on metals. Machine is made by Marquardt Corp., Van Nuys, Calif.

RIVETT SQUAREMASTER "100" CYLINDERS

Unfailing POWER for MILLIONS of cycles!

Here's sure power for unfailing cylinder operation. SQUAREMASTER 100's are the world's finest constructed cylinders—perform with 100% efficiency! 200 P.S.I. air to 500 P.S.I. oil. Available in 7 mountings with standard dimensions, in 10 bore diameters, internal and external threading. Special models and cover combinations. Priced competitively; prompt delivery; meet all J.I.C. requirements.

RIVETT, INCORPORATED

Dept. HP-11, Brighton 35, Boston, Mass.

*Initial High Coefficient of Static Friction

POWER-PACKED FEATURES PROTECTED BY POWER-GUARD CONSTRUCTION

1. Piston rod. Ground and polished alloy steel. Hard chrome-plated. **2.** Piston rod bearing. Replaceable cartridge-type. **3.** Piston packing adjusts automatically. V-block packing minimizes friction. **4.** Correctly stressed tie rods. **5.** Cushion bushings. Bronze, floating type. **6.** Ports rotated to any 90° position. **7.** Steel covers. Take minimum mounting space.

Send for catalog. Proof of SQUAREMASTER efficiency stated in these 20 pages. Write today.

RIVETT furnishes a complete power package

AIR AND HYDRAULIC — VALVES, CYLINDERS, POWER UNITS

Member — National Fluid Power Association

AUTOMATIC PRESSURE CONTROL

Positive

insurance for the work!
protection for the system!

Use **FULFLO** Hydraulic Valves wherever specific pressure must be maintained: machine tool hydraulic systems, oil burning equipment, hydraulic rams and presses and other applications.

FULFLO design offers shear-closing action to eliminate chattering, sliding piston for full flow opening, easy adjustment within pressure range or quickchange of the pressure range . . . trouble-free service in any installation!

• Screw or flange models • Pressures to 600 pounds • Pipe sizes to 3" • Steel, cast, iron or brass bodies • Brass, steel or stainless trim • All-steel for extra safety

SPECIALS engineered to your most exacting needs! For complete information, request a copy of the **FULFLO** Valves Mechanical Data Book with specifications, dimensions and engineering data.

THE FULFLO SPECIALTIES COMPANY, INC.
415 Fancy Avenue Blanchester, Ohio

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FLUID POWER AT WORK

Western Metal Exposition

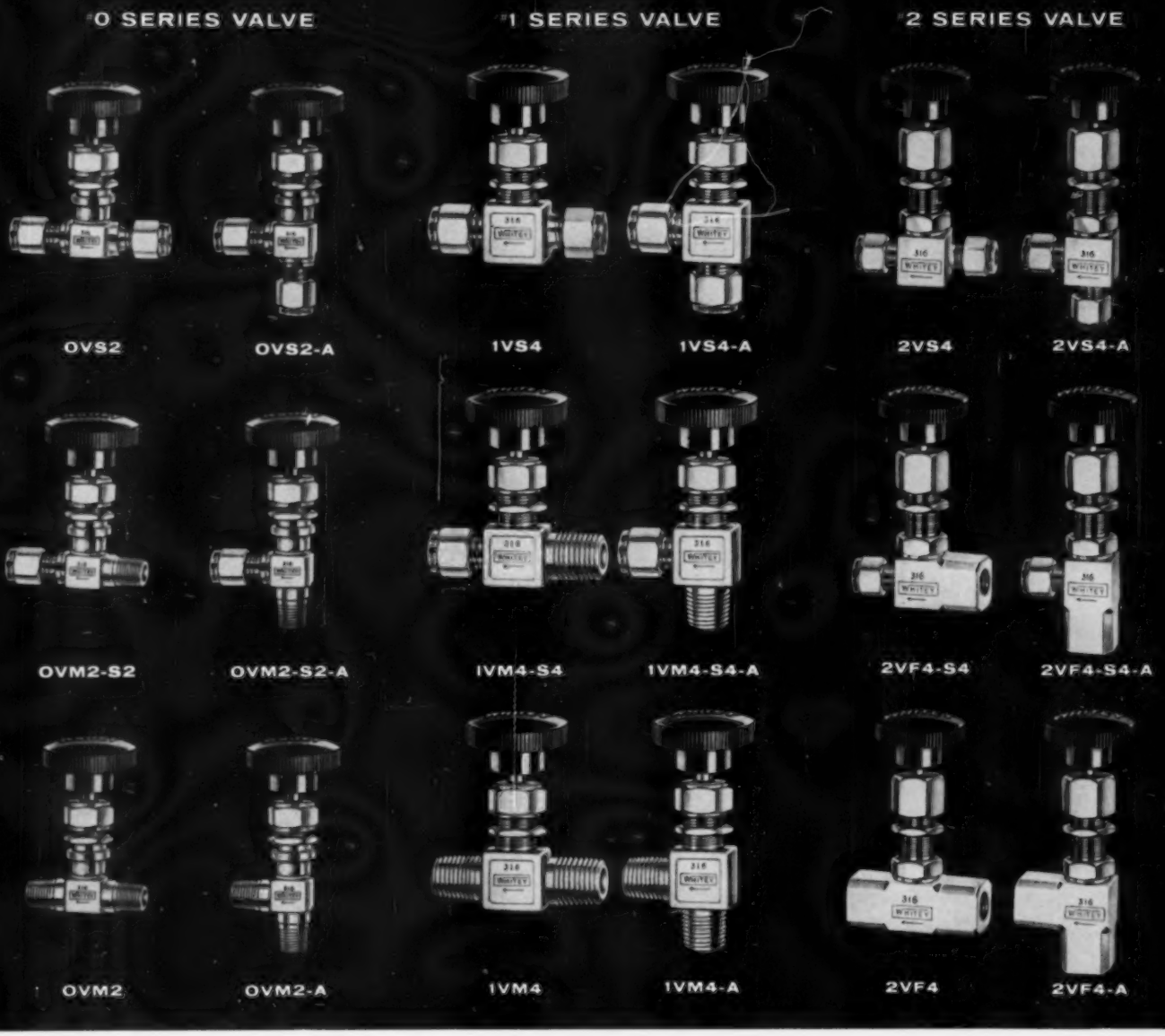
DUAL HYDRAULIC CYLINDERS deliver pulsating loads in fatigue testing machine. Manufactured by Riehle Testing Machines, Div. American Machine and Metals Inc., East Moline, Ill., the tester can deliver 60,000 lbs dynamic force at 3000 psi.

INDUSTRY'S SMALLEST automated turret drill manufactured by Burgmaster Corp., Gardena, Calif., uses four pneumatic cylinders to index, feed, and position the work.

IN PROGRAMMED SEQUENCE, pneumatic valves actuate the lead screw and indexing table drill press made by Jarvis Corp. of America.

Circle 160 →

WHITEY MINIATURE VALVES



WHITEY Research Tool Co. manufactures a complete stock of small valves designed for instrumentation work or any application demanding flawless performance in fluid or pneumatic systems.

The WHITEY Valves above illustrate some of the wide variety of connections available in ⅛" and ¼" pipe and tube sizes. These valves are stocked locally by your WHITEY Distributor.

In answer to customer demand, all WHITEY Valves through ½" size are available with Swagelok Tube Fitting Connections to facilitate ease of installation and positive, leakproof performance. Male and female pipe connections through ½" size are also available.

Panel mounting; Teflon* cylinder packing; micro-regulating and non-regulating stems are standard features on all WHITEY Valves.

For color coding purposes, colored handles may be specified when ordering WHITEY Valves.

*Dupont

Complete technical data on WHITEY Valves available on request

FOR EXACTING SERVICE WHITEY

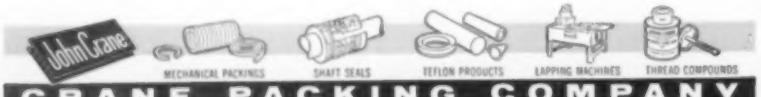
WHITEY RESEARCH TOOL CO. • 5525 MARSHALL STREET • OAKLAND 8, CALIFORNIA

New Hydraulic Packing Designs..... Specification & Application Data....

Here is complete information on the finest available line of hydraulic packings . . . an extremely wide variety of types and constructions, each correctly compounded to particular service requirements and laboratory controlled to insure uniform quality. Available now from "John Crane", this complete line is the answer to practically every hydraulic packing requirement.

Request Catalog 90. You can't afford to be without this detailed engineering guide.

Crane Packing Co., 6405 Oakton Street, Morton Grove, Illinois *(Chicago Suburb). In Canada: Crane Packing Company, Ltd., Hamilton, Ont.*



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FLUID POWER AT WORK

Wanted: Old Cylinders

Plant and design engineers will be wiping off cylinder name plates in an attempt to find the oldest hydraulic or air actuated cylinders made by Hanna Engineering Works, Chicago, and still in use in a factory anywhere in the United States.

Cash rewards totalling $300.00 will be given to the men finding the three oldest cylinders still in operation. The company would like to exchange some of the oldest cylinders for new power cylinders of the same design. The old cylinders will be returned to the company's plant where they will be studied and then placed in the power cylinder display.

From this Reward-Search, the Hanna company expects to learn additional and unusual uses of power cylinders and new tips on good maintenance procedures.

FPS News

The Fluid Power Society has been formed to further the development and use of fluid power. Membership information is available from headquarters at 5595 N. Hollywood Ave., Milwaukee 17, Wisc.

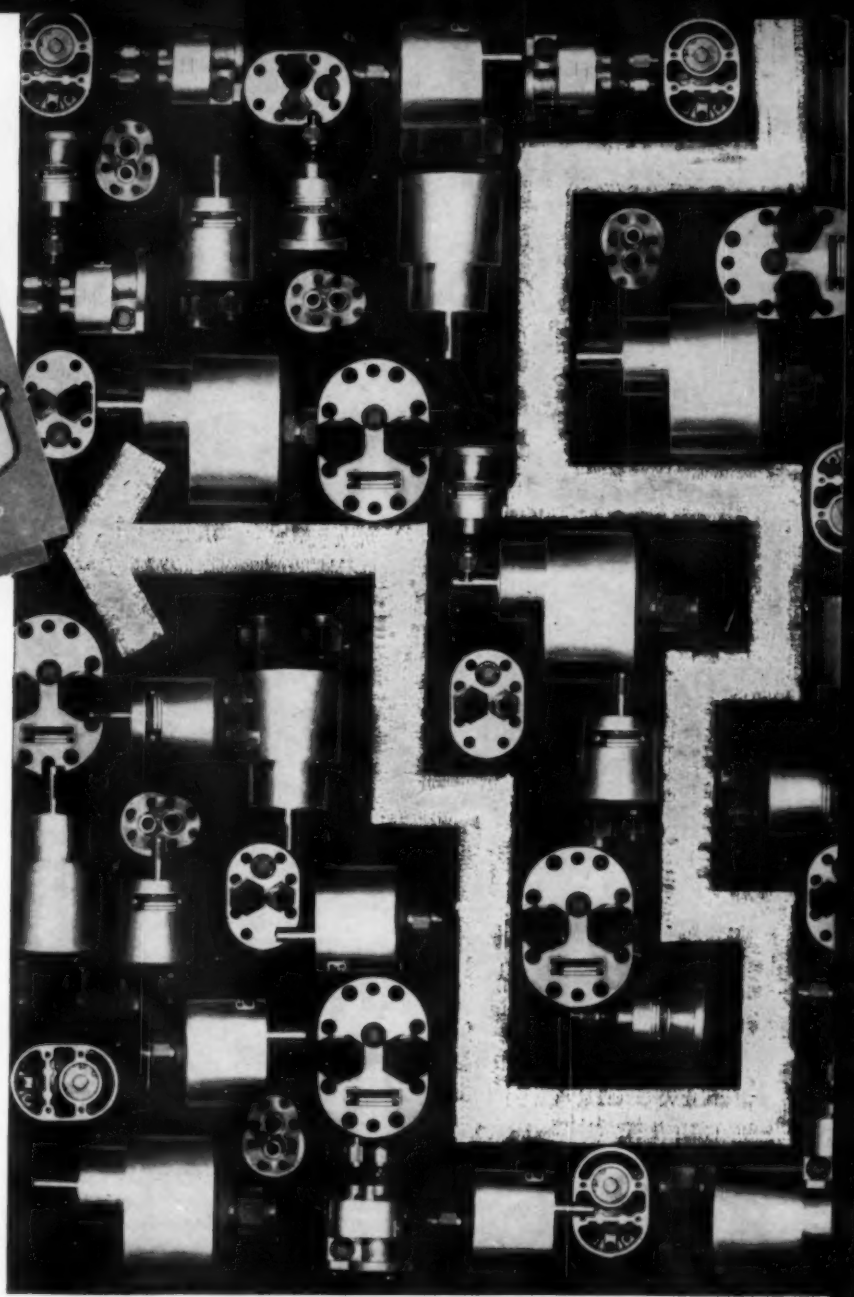
Cleveland Chapter

The following officers were installed last September to head the Chapter during the coming year. President: Allan Morris, HYDRAULICS & PNEUMATICS; Vice President: Les Henderson, Republic Manufacturing Co.; Secretary, Barry Evans, Universal Hydraulics; Treasurer: Harold Olms, The Glastic Corp. A panel of four representatives of the hydraulic fluid industry then participated in a lively lecture-debate program on "What You Should Know About Hydraulic Fluids."

- **Petroleum Hydraulic Fluids** —Properties of petroleum fluids

Continued on page 46

Circle 46 →



your guide to *the gear pump* for your application

This new catalog is an invaluable directory to no less than 129 pump-and-electric-motor-combinations — any and all available off-the-shelf!

Searching for gear pumps with top volumetric efficiencies? Do your performance requirements fall into one of these three major groups?

- Eastern 1200 series — up to 1.6 gpm — pressures to 800 psi
- Eastern 100 series — up to 5 gpm — pressures up to 1500 psi
- Eastern 700 series — up to 9.8 gpm — pressures up to 1500 psi

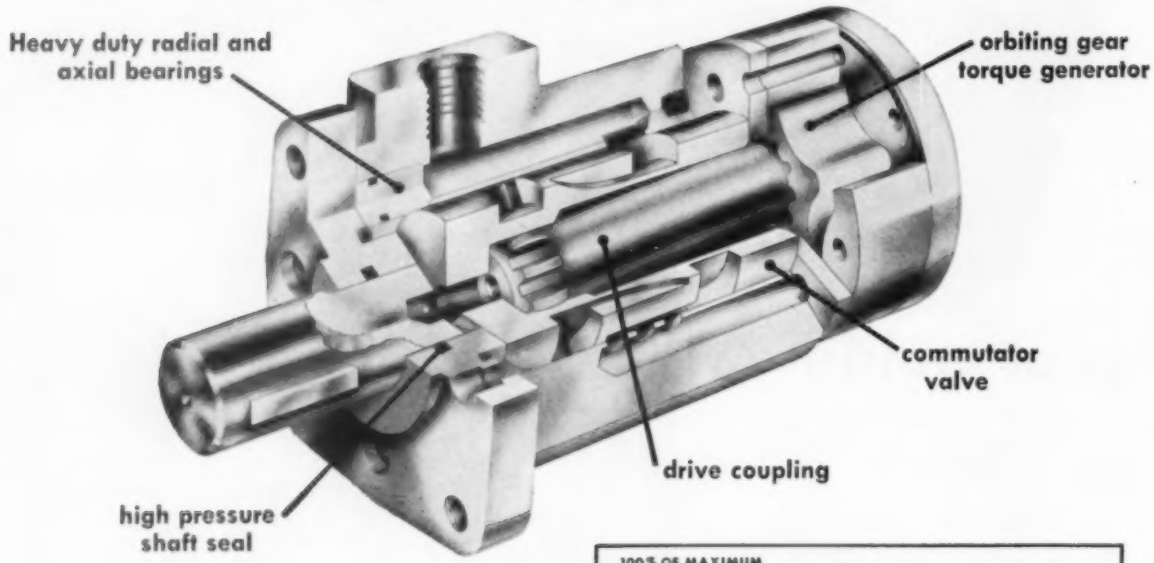
If one or more of these performance ranges measures up to what you need, save hours of searching your way through the gear pump maze — send for catalog 810 now!

Other Eastern products:

- **hydraulic motors**
- **positive displacement pumps**
- **centrifugal pumps**
- **aircraft pumps**

EASTERN INDUSTRIES, INCORPORATED
Hamden, Connecticut

New Hydraulic Motor Design Provides High Torque at Low Speeds



ORBIT MOTORS®...

DELIVER MORE TORQUE PER LB and AT LESS COST

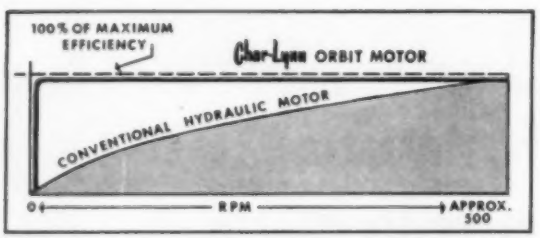
The Orbit principal utilizes an internal gear mechanism to act both as a fluid displacement motor and a gear reducer. The outer segment is a stationary part of the motor housing and has internal gear teeth which mesh with corresponding teeth on a smaller gear or rotor which rolls inside the outer gear, turning about an eccentric axis in an ORBIT.

The rotor gear rolls through six complete orbits during each single rotation of the output shaft. Thus an effective speed reduction of 6-to-1 is obtained. The use of seven fluid chambers with the inherent 6-to-1 ratio provides 42 fluid power cycles per shaft rotation, a distinct advantage in obtaining smooth rotation.

As it rotates, the rotor gear causes a continuous opening and closing of the spaces between the teeth. Half of these spaces are subjected to fluid pressure and the opposed half is connected to the return section of the motor.

The rotary commutator valve distributes the fluid so that the pressured space rotates in phase with the rotor gear, thus causing continuous rotation. Motion of the rotor gear is transmitted to the output shaft by a coupling which has crowned involute splines to match the bores of the output shaft and the rotor gear.

The high pressure shaft allows ORBIT MOTORS to be operated "in series" without external drain lines.



High efficiency over complete operational range

- **Speeds from 0 to 800 rpm**
- **Torques to 3300 inch lbs.**
- **Starting torque substantially equal to running torque**
- **Full reversible—instant starting, stopping**
- **Only 3 moving parts**
- **4 types of mountings available**
- **3 port sizes, 7 power element selections**
- **Compact, light weight**
- **Eliminates costly and complicated power transmissions**
- **High volumetric and overall efficiency**

For Complete Details Write—

CHAR-LYNN COMPANY, DEPT. H. M.
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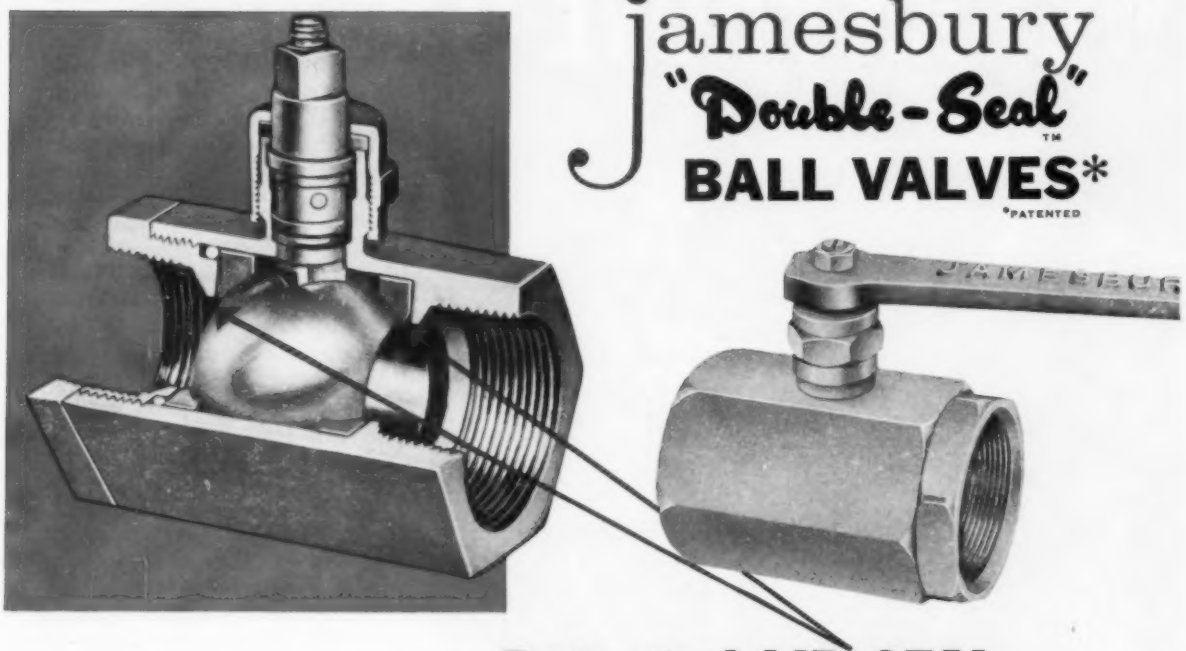
Char-Lynn
HYDRAULIC HORSEPOWER PRODUCTS

FACTS You Should Know About

jamesbury "Double-Seal"™ BALL VALVES*

*PATENTED



jamesbury's Patented LIP SEAL Compensates For Temperature, Pressure and Wear

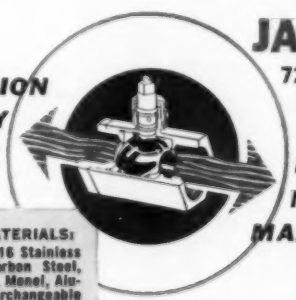
Behind the long life and leaktight performance of Jamesbury "Double-Seal" Ball Valves is the Jamesbury lip seal principal. This patented lip seal feature provides compensation for temperature, pressure and wear. That's why Jamesbury "Double-Seal" Ball Valves maintain their tight seal *longer!* Moreover, with the Jamesbury "Double-Seal" Ball Valve, you get zero stem leakage.

There are other unique features about the Jamesbury Valve. It's available in a wide range of materials and sizes. It is of compact body design. The stem can be removed from the valve under pressure with the valve in full closed position with no leakage occurring.

Want more facts? Contact your nearest stocking distributor, or write us direct.

JAMESBURY CORP.
72 New Street, Worcester, Mass.
DISTRIBUTORS IN PRINCIPAL CITIES

QUARTER TURN OPERATION
HIGH FLOW CAPACITY
ZERO LEAKAGE



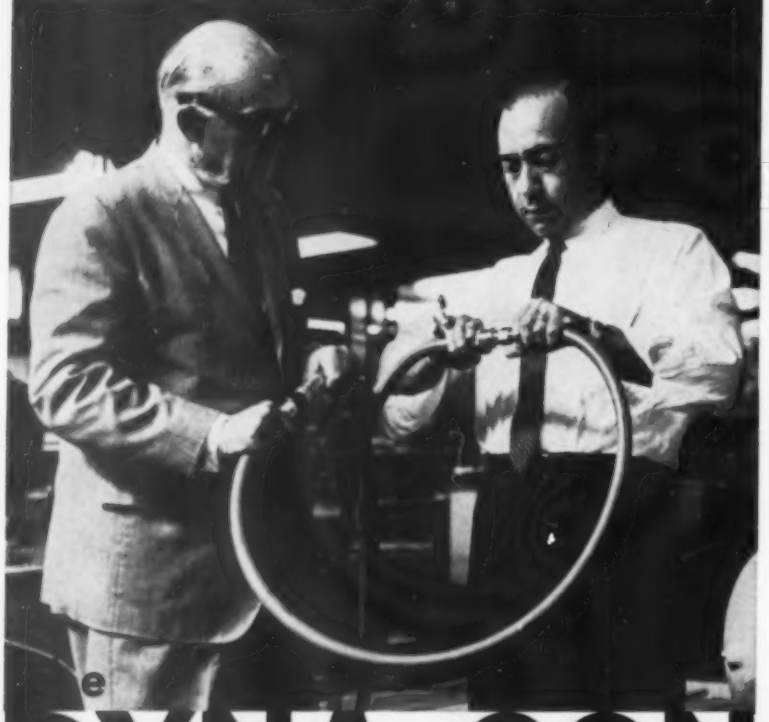
NO LUBRICATION REQUIRED
MINIMUM MAINTENANCE
MANUAL OR POWER OPERATION

WIDE RANGE OF SIZES:	VARIETY OF MATERIALS:
Screwed end ¼" through 3". Flanged 150# series ½" through 12" — 300# ½" through 6". Larger sizes on request.	Valves in 303 and 316 Stainless Steel, Alloy 20, Carbon Steel, Bronze, Ductile Iron, Monel, Aluminum and PVC. Interchangeable seats and seals in Teflon, Teflon compounds, Nylon, Buna-N, Neoprene, Hypalon and natural rubbers.

As Versatile As Industry Itself!

©Jamesbury Corp. 1961 175-1

WE CAN PROVE IT



DYNA-CON

DOES OBSOLETE YOUR PRESENT PNEUMATIC COUPLINGS

Don't take our word for it. We've told you that the DYNA-CON OBSOLETES present pneumatic couplings . . . that it's the easiest to connect by far . . . the safest by far . . . and the most economical as well! If we were in your shoes, we'd want proof. Let us prove it to you with our simple five minute demonstration in your plant. Call, write or wire DYNA-QUIP today . . . prove to yourself how revolutionary the DYNA-CON really is!

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Circle **45** on Reader Service Card

FLUID POWER AT WORK

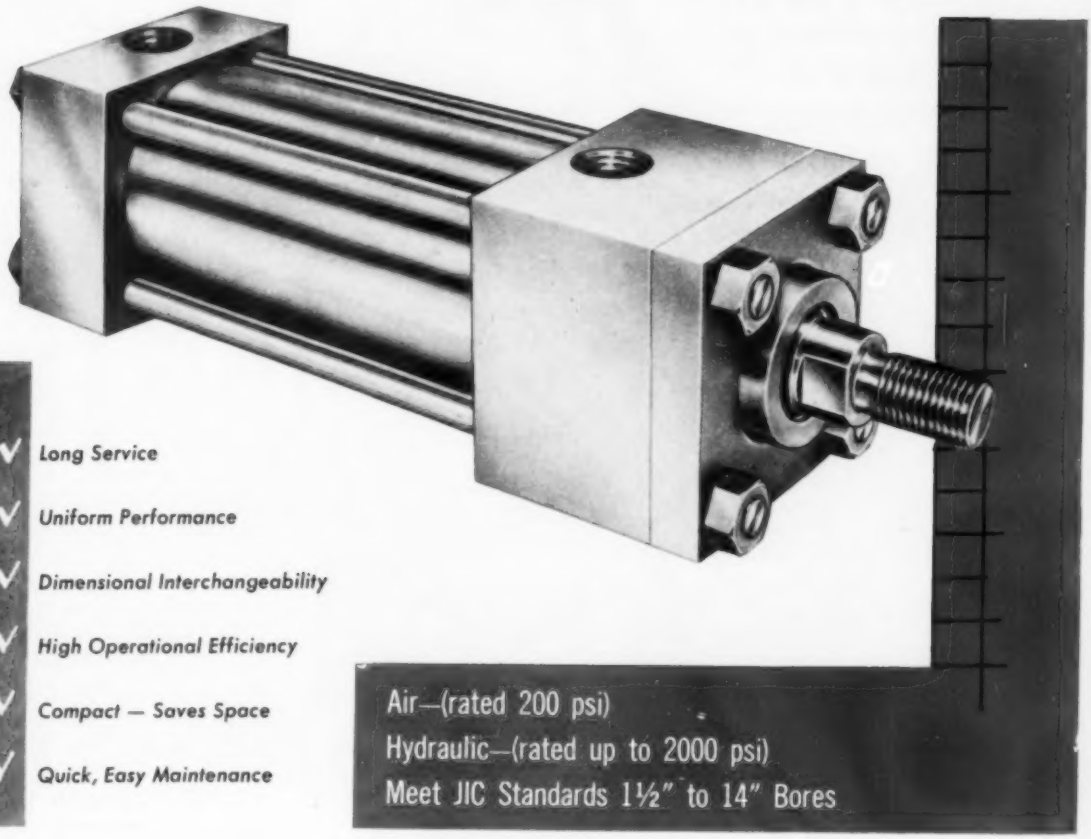
were presented by Harold Cannell, Lubrication Engineer, Standard Oil Co. of Ohio. He reviewed the desirable properties of oils, their chemical stability, oxidation and corrosion resistance, lubrication, oil viscosity, viscosity index, and pour point.

- **Water-Oil Emulsion Fluids**—J. H. Minnick, Lubrication Special Products Dept., Shell Oil Co., pointed out that most of the development work of water-oil fluids has been done in the last seven or eight years. He indicated that the important value of fire resistant fluids is that they will not let a flame spread should a stream of the fluid accidentally come in contact with a source of ignition.
- **Water-Glycol Fluids**—These fire-resistant fluids were discussed by William Eismann, National Manager, Lubrication Sales, E. F. Houghton Co. These snuffer type fluids are made of water, glycol, synthetic thickeners, and additives. They are alkaline with an average pH of 8.5. Mr. Eismann also described some of the test to which these fluids are subjected to check their resistance to combustion and their ability to resist spreading flames.
- **Phosphate Ester Fluids**—Dale Smith, Monsanto Chemical Co., compared the properties of fire resistant synthetic fluids with other fire resistant fluids. He

Continued on page 50

HYDRAULICALLY ACTUATED loader-unloader for handling baggage at airfields is built by Airseco, Inc., Jamaica, N. Y. Unit has special aluminum truck body, 133-in. conveyor boom actuated by telescoping cylinder, and hydraulic rear gate. Hydraulic gate is 64 in. wide, 53 in. deep and has a load capacity of 3000 lbs.

NEW O-M SQUARE-HEAD AIR AND HYDRAULIC CYLINDERS GIVE THE PERFORMANCE YOU EXPECT . . . AND MORE



- ✓ *Long Service*
- ✓ *Uniform Performance*
- ✓ *Dimensional Interchangeability*
- ✓ *High Operational Efficiency*
- ✓ *Compact — Saves Space*
- ✓ *Quick, Easy Maintenance*

Air—(rated 200 psi)
Hydraulic—(rated up to 2000 psi)
Meet JIC Standards 1½" to 14" Bores

Made of the highest quality materials and seals, these new components combine modern design, the latest and best engineering advancements with O-M specialized "know how" and precision workmanship.

New Series "K" Air Cylinders

Construction features include brass cylinder barrel, chrome-plated, high tensile steel piston rod with a minimum yield strength of 90,000 to 100,000 psi. Rolled and machined steel heads and extra long cartridge-type rod bearing assure perfect alignment of piston rod.

New Series "L" Hydraulic Cylinders

Similar in many construction features to Series "K", but specifically designed for hydraulic service. Incorporate vee-type rod packing and a cylinder barrel of micro-honed steel tubing which are best suited for hydraulic operations.

With the addition of the new Series "K" and "L" to the Ortman-Miller major line of air and hydraulic cylinders, you can now rely on O-M for *all* of your low and medium pressure cylinder requirements. Both Series "K" and "L" are dimensionally interchangeable with other cylinders of a like type. Fabricated, precision steel mounts and accessories assure precise mounting.

Mail coupon today for complete details. All cylinders in Bulletins 115A and 116 have been dimensioned in accordance with NFPA recommendations for your convenience.

ORTMAN-MILLER MACHINE COMPANY
1 143rd Street, Hammond, Indiana

☐ Have representative call
Please send Bulletin(s)

☐ 115A–Series "K" ☐ 116–Series "L"

NAME_____

POSITION_____

COMPANY_____

ADDRESS_____

CITY_____ ZONE____ STATE_____

FLUID POWER AT WORK

pointed out that fire resistant fluids were first used on commercial airplanes in 1948, today all jet airliners specify them. Mr. Smith then discussed straight phosphate ester, phosphate ester base, and chlorinated hydro-carbon base fluids.

Conference Stresses High-Pressure Hydraulics

MILWAUKEE—A one-day seminar on high pressure hydraulics was sponsored in September by the Dynex Co. and held at its plant in Pewaukee, Wis. This was the third meeting held in conjunction with SAE's annual National Farm—Construction and Industrial Machinery Meetings.

Concepts in high pressure hydraulic technology were presented by Mr. Wesley R. Master, Dynex Director of Engineering. He cited some of the many advantages and features of high pressure systems: smaller and lighter components, reduced oil heating problems, and greater mechanical efficiency.

After hearing prepared papers on hydrostatic transmission applications, the 75 representatives from industry were shown laboratory and field demonstrations of high pressure mobile equipment in action.

• **Spike Puller is Hydraulic**—The circuit of a hydraulic spike puller was discussed by Mr. N. Lind of Fairmount Railroad Motors Co., Fairmount, Minn. In the original design of this machine, the pump delivered full flow to the spike-puller cylinder at system pressure of 3100 psi. However, it was observed that most spikes did not require the pressure of a 3000 psi system and could be pulled with 1500 psi. Only occasionally were higher pressures required to loosen a spike and extract it from the railroad tie. In the redesigned circuit, a split flow pump was installed: one half to be relieved at 3100 psi, the other at 1500 psi. During normal operation, the

Continued on page 54

HYDRAULIC CONTROL ROD DRIVE FOR N. S. SAVANNAH

PHOTO COURTESY NEW YORK SHIPBUILDING CORPORATION

DESIGNED AND MANUFACTURED BY RUCKER

The Rucker Scram and Monitoring system maintains an even balance of the N. S. Savannah's reactor, reduces load on the drive mechanism system, assures instantaneous shutdown, and automatically activates reserve power systems.

The Rucker Company offers unparalleled experience in the design and manufacture of electro-hydraulically actuated reactor control rod drive systems for extreme reliability, unequalled response time achievements of 25 milliseconds and less, stored energy, minimum maintenance in hot areas, and positive monitoring from remote locations.

When your problem involves fluidynamic power, you can rely on Rucker . . . a leader in hydraulics and in power and control systems since 1941.

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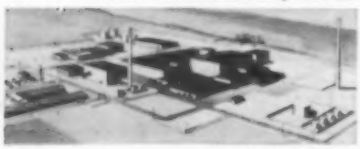
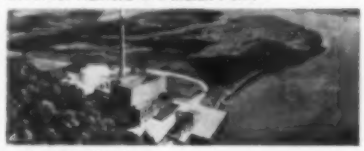
Other Shim and Scram Systems built by Rucker for Hanford and Indian Point





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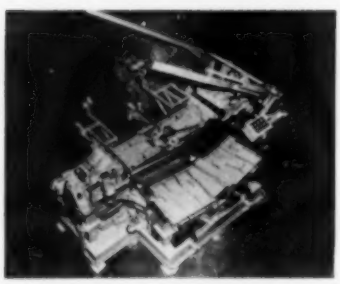


THIS COMPACT HOOD FLANGER has hydraulically powered dies to bend metal against back-up bars. The flanging operation, used by Chevrolet's Stamping Plant, Flint, Michigan, has a pneumatic positioner which locates the piece for the work cycle. Direct operated hydraulic clamps hold the piece as the back-up bars move into position. The flanging dies are sequenced to move against the back-up, bending the metal. Built by National Welding Machines Co., Bay City, Michigan, this unit has a twin in the fender line. The fender hemmer uses a stationary back-up and a hydraulic operated swinging clamp to hold the work. A hydraulic cylinder operates a pair of sequenced dies which make the hem.

Circle **146** →

WEAR RESISTANT
THOMSON

60 Case

AVOID the HIGH COST and difficulty of fabricating long, hard & straight parts by conventional methods!

hardened and ground

SHAFTS, ROLLS, GUIDE RODS and other long-round parts

ELIMINATE WEAR and REDUCE COST

60 Case is the result of over 15 years of experimental work and production experience with hardened and ground shafts which are a requirement for BALL BUSHINGS, the Linear Ball Bearing manufactured by Thomson Industries, Inc.

The special techniques and equipment that have been developed enable high production rates and low handling costs. This permits big savings over conventional methods which are plagued with erratic warpage, straightening and resultant grinding problems. Finished *60 Case* parts frequently cost less than the scrap losses that result from conventional methods.

60 Case material has a surface hardness close to 60 on the Rockwell C scale which is essential to resist wear.

Long lengths of material ranging in diameter from ¼" to 4" are stocked to enable prompt shipment of *60 Case* parts, with or without special machining. *Write for literature and name of your local representative.*

For emergency needs call collect
MAnhasset 7-1800

ADVANTAGES of *60 Case*

- COST REDUCTION
- HARD BEARING SURFACE
- NICK-& DENT-PROOF
- ACCURATE DIAMETERS
- GROUND FINISH
- STRAIGHT PARTS
- DELIVERY FROM STOCK
- ADDED STRENGTH
- UNIFORM HIGH QUALITY

TYPICAL *60 Case* PARTS

GUIDE RODS • SHAFTING • ROLLS • TRAVERSE RAILS
PISTON RODS • ARBORS • LEADER PINS • TIE RODS
KING PINS • AXLES • CONTROL RODS • GUIDE POSTS
MANDRELS • BEARING ROLLERS • SPINDLES

THOMSON INDUSTRIES
Inc.
Dept. C-4, Manhasset, New York

PARTS HARDENED to 60 C...
increase life...reduce cost!

For

non-pulsating flow...

DE LAVAL

IMO®

power-hydraulic

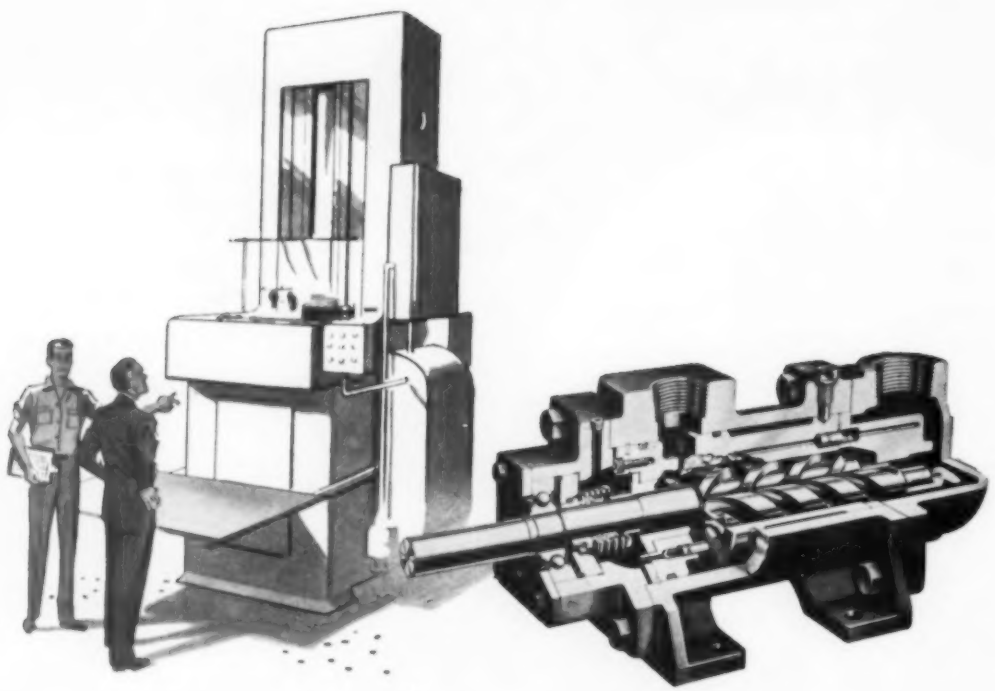
pumps

Fluid delivery is continuous; flow is pulsation-free. There are no intermittent strokes, no churning. Applications for which non-pulsating IMO pumps are ideally suited include many broaching operations, for example, where pulsation can cause irregularities in the finish.

Versatile IMO pumps deliver maximum performance in many varied power-hydraulic applications. Besides non-pulsating flow, IMO pumps offer quiet operation, high speed, wide capacity range, and reliability . . . even with fire-resistant fluids. Compact design saves expensive floor space. Installed cost is lower than for other types of pumps. IMO pumps cut maintenance, too . . . only three moving parts!

For application and performance data, selection information, dimension drawings and tables, write for Bulletin IM-3200.

De Laval Steam Turbine Company, Trenton 2, New Jersey.



IM-DL-109

DE LAVAL · 60 YEARS OF CREATIVITY AND QUALITY

CENTRIFUGAL PUMPS AND COMPRESSORS • TURBINES • IMO® ROTARY PUMPS AND HYDRAULIC MOTORS
MARINE PROPULSION AND AUXILIARY EQUIPMENT • HELICAL AND EPICYCLIC GEARS • TURBOCHARGERS

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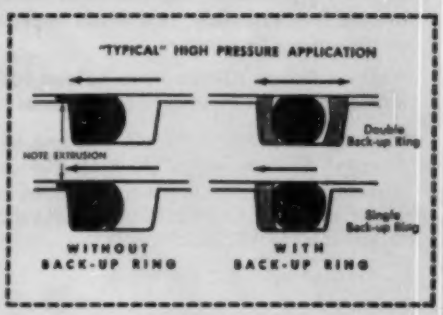
Circle 118 →

NOW – Increase O-Ring Life and Reduce Costs with...

Parbak*

The only contoured and continuous back-up ring... simplified, easy-to-assemble, resists higher pressures!

Here's the first really new back-up ring in years . . . Test after test, both in the field and laboratory, has proved that Parbaks* greatly increase O-ring life. In addition Parbaks* improve lubrication, are easy to assemble, and resist higher pressures — *yet they actually cost less* than back-up rings for similar useage!



Why not get the facts about these unique rings, now. Send for catalog 5482 — 8 pages of design data and other material about Parbaks.* It's free, of course.

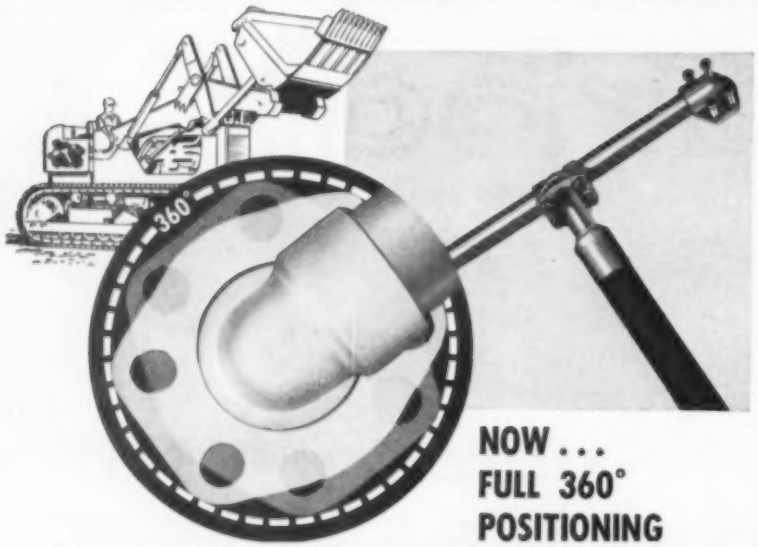
Parker SEAL COMPANY
Culver City, California and Cleveland, Ohio
A DIVISION OF PARKER-HANNIFIN CORPORATION

* Trade Mark

FOR A COMPLETELY NEW DIMENSION IN HYDRAULIC INSTALLATION FLEXIBILITY . . .

formrite

"ROTO-FLANGE" FITTINGS



NOW . . . FULL 360° POSITIONING

The continued trend toward larger volumes of oil at increased operating pressures and the diminishing space available for hydraulic line assembly, has made improved pipe-tube-hose-fitting combinations imperative.

Various flange clamps have helped facilitate small space installation, although even their use at times presents line-up problems.

To overcome this — the all new line of Formrite Rotating "Roto-Flange" Clamps with "O" Ring Flange Head Tube Fittings was developed. *For the first time,* full 360 degree positioning is possible thereby COMPLETELY SOLVING CLOSE CENTER-LINE DIMENSION REQUIREMENTS.

- available with tapped holes or clearance holes for SAE Bolts in a pad size range from ¾" to 3".
- permits larger orifice diameters and therefore greater flow capacity.
- engineered for silver brazing to the assembly, thereby eliminating stress normally introduced by welding.
- ideal for tube-to-hose or tube-to-tube connections.
- "O" Ring joint provides positive seal.
- socket wrench only tool required for installation.

FOR COMPLETE INFORMATION, WRITE . . .

formrite TUBE COMPANY

TWO RIVERS, WISCONSIN

MEDINA, OHIO

Circle **52** on Reader Service Card

FLUID POWER AT WORK

combined output flows actuate the single acting, spring-returned puller cylinder at 1500 psi. When a tightly wedged spike must be pulled, the 1500 psi line is unloaded to tank, while the other line takes over and supplies 3100 psi pressure to the cylinder. As soon as the spike is loosened, pressure drops, the unloading valve closes, and the system returns to 1500 psi operation.

• **Lift Truck Has PF, PV Pumps**—The operation of an electrically powered lift truck equipped with hydrostatic drive was discribed by Mr. R. DeMarco, Heifred Corp., Willoughby, Ohio. A battery-operated electric motor powers the truck's two pumps. One is a fixed displacement vane pump for the lift and forks. The other is variable delivery, axial piston type which supplies two, fixed displacement motors. These are connected in parallel and drive the front wheels. A spring-loaded, single-acting braking cylinder is connected in parallel with each wheel

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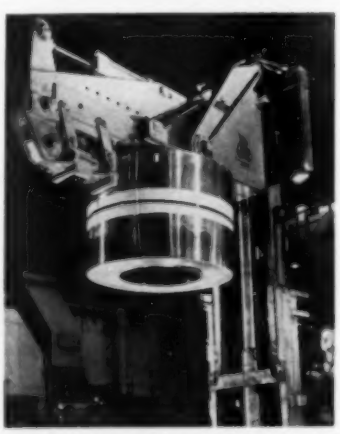
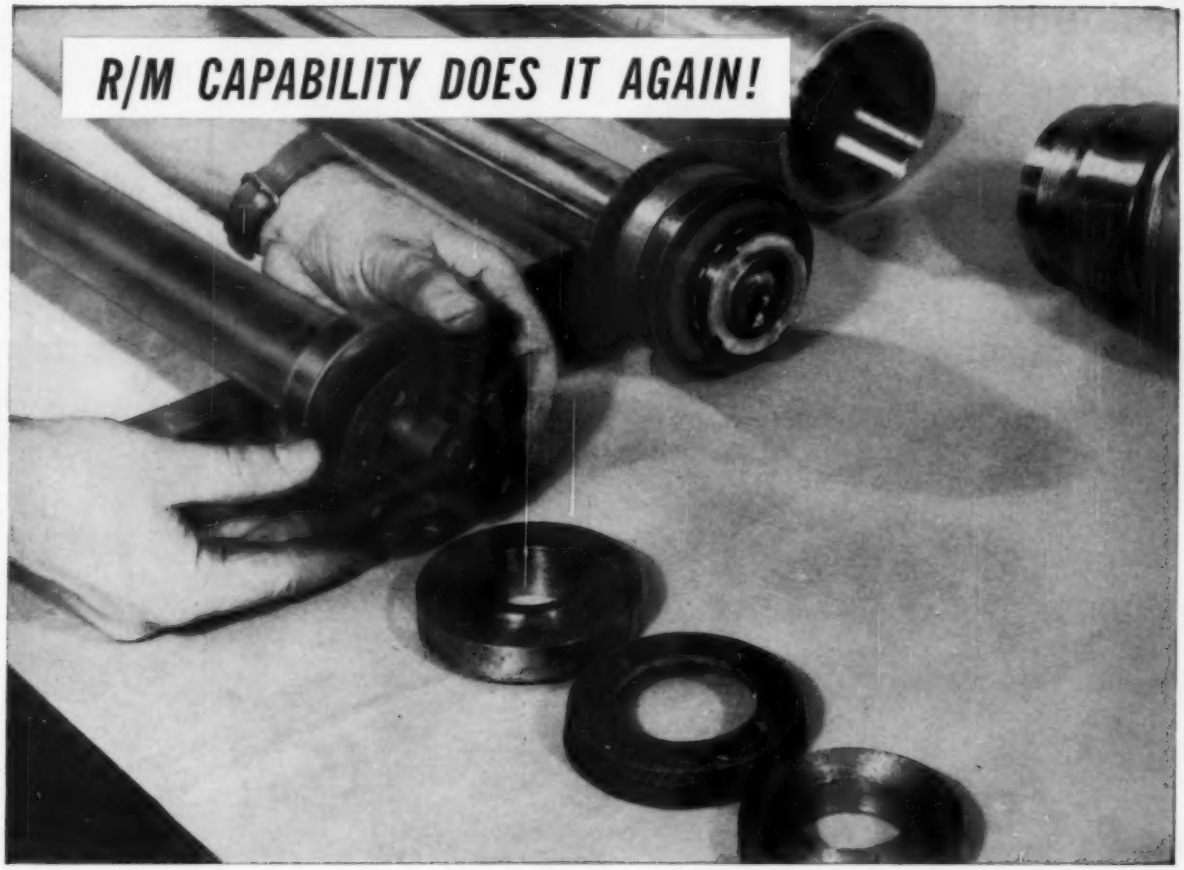


HYDRAULIC ATTACHMENT ON FORK TRUCK eases coil handling. Manufactured by Bridgeport Brass Co., Indianapolis, it is adaptable to any standard fork truck. With it, one operator can grab 6000 lbs of metal stock, lift and rotate it 90 degrees in one operation. High presure clamps adjust to the coil size and curvature while holding it securely. The truck can then move to any desired location. Coils can be stacked flat, saving space and preventing dented edges.



Solves major operating problems for tire press manufacturer with new Teflon*-impregnated molded asbestos piston cups

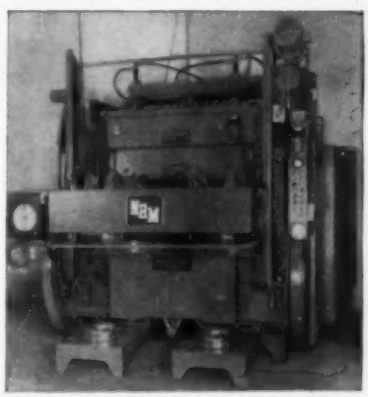
New molded asbestos piston cups impregnated with Teflon,* developed by Raybestos-Manhattan, Inc., have enabled National Rubber Machinery Company, Akron, Ohio, to improve the economy and efficiency of its Autoform Slideback Tire Press while realizing substantial savings. The new seal has not only reduced air loss to a minimum, but eliminated a lubrication system, cut maintenance, and increased machine operating life.

Before adopting R/M cups, NRM used metal rings for the ram and cylinder assembly. These did not provide the seal required, permitted a 5 to 10% air loss, caused excessive wear on moving parts, and required lubricants which were entrained, seeped into the molds, and damaged the tire rubber.

In considering a suitable replacement for the metal rings, NRM tested various synthetic rubber and leather cups. All deteriorated rapidly in temperatures up to 380°F. Then R/M was consulted. Preliminary investigation indicated asbestos with a Teflon filler as a potentially good combination for this application. Nearly a year of research, testing and engineering collaboration followed. Samples were developed and tested in the field under actual operating conditions. Only when all results were in—after two years—did NRM adopt R/M cups for use in all its presses.

R/M's experience in the manufacture of packings, gasket materials, and specialty products to meet the exacting and varied requirements of industry is at your disposal—whatever your need call on R/M.

*Registered trademark for Du Pont fluorocarbon resins



The application of R/M piston cups provided two important benefits. It eliminated oil in the curing room, preventing damage to the tire rubber. It reduced air loss with properly fitted and installed cups.

RAYBESTOS-MANHATTAN, INC.
PACKINGS
PACKING DIVISION, PASSAIC, N.J.
MECHANICAL PACKINGS AND GASKET MATERIALS

Circle 128 on Reader Service Card

One good Le Roi leads to another ...user reports

One of the machines served by the Le Roi 75S2 is the rivet drilling machine. The operator is shown gauging one of the drilled tubular rivets prior to finishing.

LE ROI 75-HP STATIONARY COMPRESSOR

First air-cooled Le Roi finishes 5 years of service with just routine cleaning and oil changes!

Shown above is a Le Roi 75S2 compressor recently installed at John Hassall, Inc., Westbury, Long Island, manufacturer of job-designed fasteners and parts.

Picking Le Roi came naturally when Hassall found need for additional air power. Their last Le Roi has worked for five years without trouble, and has required only filter cleaning and oil changes for upkeep.

Hassall was convinced they could save 30% on installation, get more air from less space, and reduce maintenance time about 40% if they installed the air-cooled Le Roi 75S2 rather than a water-cooled air compressor.

Moreover, Le Roi compactness permits installation *near the point of use*, with less piping and air loss. Air-cooling eliminates costly plumbing and water-line freeze-ups . . . permits indoor or outdoor installation. Dual control gives you constant speed or automatic start-stop operation.

Pick Westinghouse unit-type or Le Roi stationary air compressors for your needs. Sizes from ½ to 100 hp. See your Le Roi distributor, or write to Le Roi Division, Westinghouse Air Brake Co., Sidney, Ohio.

SC-07

LE ROI STATIONARY COMPRESSORS

PORTABLE AND TRACTAIR® AIR COMPRESSORS • STATIONARY AIR COMPRESSORS • AIR TOOLS

motor. The brakes are applied when pressure at the wheel motors drops below 50 psi. When oil pressure increases beyond 50 psi, the cylinders extend, release the brakes and let the wheel motors propel the truck. When oil pressure drops to 50 psi the springs retract the cylinders and the brakes take hold gradually and automatically. ▼▼▼

BRIEF NOTES

RESEARCH AT BATTELLE MEMORIAL INSTITUTE . . . A chart showing research work at Battelle Memorial Institute, Columbus, Ohio, is available to those interested in research and development. The Institute does work in fluid mechanics, servomechanisms and controls, and product engineering.

DOWTY GRANTS LICENSE TO JAPANESE FIRM . . . Dowty Hydraulic Units Ltd., Ashchurch, England, has announced that it has signed a license agreement with Kayaba Industry Ltd. of Tokyo, to manufacture Dowty Hydraulic gear pumps and motors in Japan. The Japanese firm will have exclusive marketing rights in Japan, Formosa, Korea, and Indonesia.

BALL VALVES TO BE MADE IN ENGLAND . . . The Jamesbury Corporation, Worcester, Mass., and Serck Ltd., the Birmingham engineering group, have formed Jamesbury-Serck Ltd. in Gloucester, England to manufacture and market Jamesbury Double Seal ball valves and related products.

NUMERICAL CONTROL SYSTEM FOR FACTORY PRODUCTION . . . A new computer language, designed to broaden the use of numerically-controlled machine tools for automated production of complex parts, was demonstrated by International Business Machines Corp. The Autoprompt program will enable the user to describe the surfaces of three-dimensional shapes to be milled, rather than each path the tool must follow to machine the part.

KEARFOTT OPENS NEW SALES OFFICE . . . Kearfott Division, General Precision, Inc., Little Falls, New Jersey, has announced the opening of a new sales office in Minneapolis, to serve the Northern Midwest area.

NEW PACKING FIBER . . . An improved Teflon TFE-fluorocarbon fiber, specifically developed for braided packing for pumps and valves, is now available from du Pont.

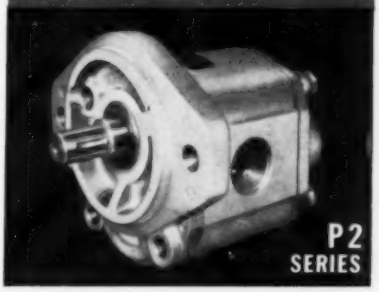
COMMERCIAL FILTERS CONSOLIDATES . . . Consolidation of all administrative functions pertaining to Fulflo, Honan-Crane, Delpark and Michiana filter lines has been completed by Commercial Filters Corp. at its Melrose, Mass., executive offices. The move has involved only the relocation of administrative, sales and engineering personnel from the company's Lebanon, Indiana plant.

KOPPERS DEDICATES RESEARCH CENTER . . . Koppers' newest and largest research facility was recently dedicated at Sommerville Park, Monroeville, Pa. The research center will become the headquarters of the company's Research Development.

STANDARDS FOR COMPUTERS . . . Standards to cover industrial process and machine tool numerical control computers and related equipment will be undertaken by the American Standards Association. The work is to be done later this year.

INVESTS IN CANADIAN HYDRAULIC FIRM . . . Dominion Brake Shoe Co., Ltd., a wholly-owned Canadian subsidiary of American Brake Shoe Co., has acquired a minority interest in Jarry Hydraulics Ltd., Canadian producer of aircraft landing gear and steering systems, and major manufacturer of airborne hydraulic equipment.

TO PUT YOUR HYDRAULIC POWER TRANS-MISSION IDEAS TO WORK:



Use Wooster hydraulic pumps to lengthen the life of your products and greatly improve their performance—at far lower cost. *Controlled* pressure loading* is built into every Wooster pump, regardless of capacity. Internal hydraulic forces pushing against bearing faces are *exactly* counterbalanced by carefully calculated pressure from the outlet area.

*Patent Nos. 2420622, 2823615, 2824522, others applied for. In pumps without this advanced design feature, wear is accelerated and pump life shortened by undue loads on bearing faces.

P2 SERIES HYDRAULIC PUMP

Capacities 1.7 to 6.8 GPM at 2000 RPM and 2000 PSI
Displacement 0.2 to 0.85 cu. in.
Speeds to 4000 RPM

Special alloy tin-aluminum bearings, all interchangeable . . . double lip shaft seal . . . hardened and ground steel gears and shafts . . . high quality, high tensile aluminum bodies. A variety of porting, mounting and drive arrangements.

WOOSTER DIVISION B-W

BORG-WARNER CORPORATION
WOOSTER, OHIO
For Mechanical Power Transmission, See Warner Automotive Division

Circle **163** on Reader Service Card

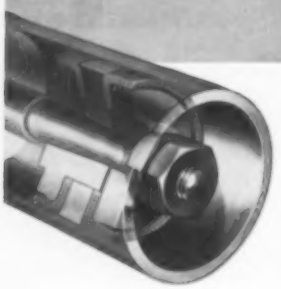
DARCOVA

PUMCUPS

pressure-seal automatically

for maximum efficiency

and longest service life



Pistons are made in a wide range of sizes in bronze, steel, aluminum or iron.

Our sales engineers will be glad to work with you on your designs. Write, wire or phone for Darcova service.

● **Virtually no slippage—fluid or air pressure keeps cup in close contact with liner automatically, regardless of wear.**

● **No need for "jammed in" packing—close tolerance of cup (.005") provides uniformly tight seal around entire perimeter.**

When you design hydraulic and pneumatic mechanisms or reciprocating pumps, be certain of maximum performance—specify Darcova Pumcups and Pistons.

Pumcups operate at full efficiency throughout their entire life—*outlast ordinary packings at least 3 to 1!* And they perform equally well in air, oil, water, glycerine, alcohol, and other fluids common to hydraulic systems.

Pumcups are available in three textures—hard, medium and soft, in regular or nylon composition. Sizes range from ¾" to 20".

DARLING VALVE & MANUFACTURING CO.
Williamsport 15, Pa.

DARCOVA
THE ORIGINAL COMPOSITION CUP

TRADE MARK PUMCUPS

Circle **39** on Reader Service Card

FUTURE EVENTS

SAE COMMITTEE G-3 SEMI-ANNUAL MEETING

(Hydraulic & Pneumatic Hose & Fittings for Aircraft, Missiles & GSE)

November 15-17

Marriott Motor Hotel
Washington, D .C.

ASME WINTER ANNUAL MEETING

November 26-December 1

Statler Hilton Hotel
New York

ASME FLUID POWER SYSTEMS DIV. MEETING

November 28

Engineers' Club
Philadelphia

NATIONAL PLANT ENGINEERING & MAINTENANCE SHOW

January 22-25

Convention Hall
Philadelphia

ASME-SAM MANAGEMENT ENGINEERING CONFERENCE

April 5-6

Statler Hilton Hotel
New York

ASME PRODUCTION ENGINEERING CONFERENCE

April 24-26

Van Curler Hotel
Schenectady

ASME DESIGN ENGINEERING CONFERENCE & CONCURRENT SHOW

April 30-May 3

Chicago Exposition Center

ASTME ENGINEERING CONFERENCE & TOOL EXPOSITION

May 7-11

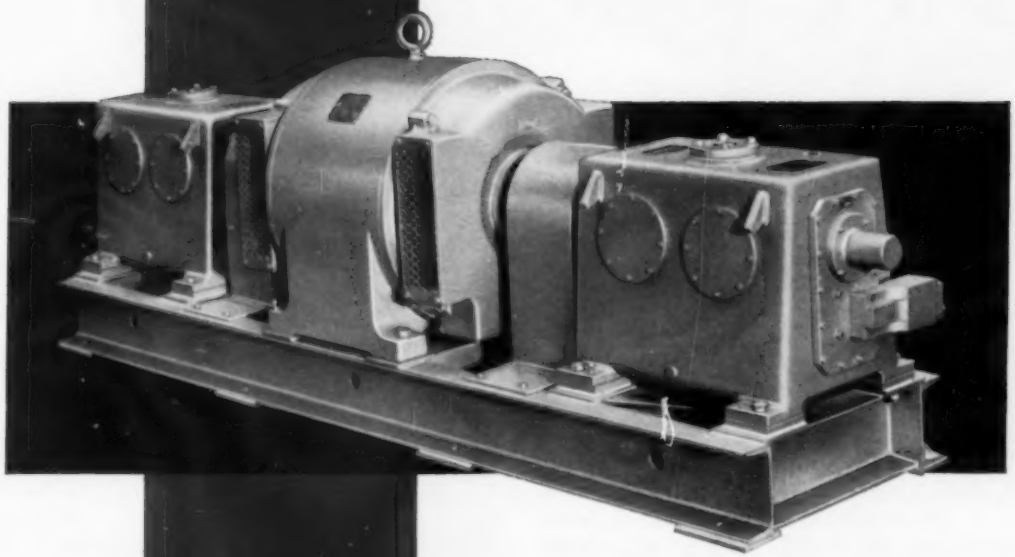
Public Auditorium
Cleveland

ASME SUMMER ANNUAL MEETING

June 10-15

Hotel Frontenac
Quebec

RELIED UPON THE WORLD OVER



TOWLER HYDRAULIC SYSTEMS

ELECTRAULIC
AUTODRAULIC

TOWLER BROTHERS (PATENTS) LTD.
RODLEY NEAR LEEDS ENGLAND
Tel: Pudsey 3125/6/7/8 Grams: 'Electrolic' Rodley

CANADA & U.S.A.:
Walter Miller, 54 Thistledown Boulevard, Thistletown, Rexdale, Ontario
Tel. CHerry 1-9128 Telegraphic Towlerbro Toronto

Circle **148** on Reader Service Card

10,000 P.S.I. SOLENOID VALVES

Important: These valves are standard catalog items.

● They are available for immediate delivery (in stock) at standard valve prices, for a service which generally requires costly (made-to-order) special valves.

● Shut off and 4-way valves in ¼, ⅜ and ½ inch port sizes are rated for 10,000 P.S.I. liquid or gases. They will withstand surges of up to 15,000 P.S.I. without damage to the valves' sealing qualities (designed for a burst pressure of 30,000 P.S.I.).
Solenoids are available for 115, 230 and 460 volt A.C. operation.

● Long maintenance-free service is achieved through the leak-proof "Shear-Seal" design. Optically flat metal to metal sealing surfaces (of the self-aligning sealing rings and the mating rotor face) are protected by staying in constant intimate contact: flow is always through the center of the "Shear-Seals," never across sealing surfaces. Sealing qualities actually improve as the seals lap themselves to a more perfect fit with each valve operation. There is no external shaft leakage because the pressure is confined to the flow passages.

For complete data write for catalog S-10000.

CONTROL VALVE DIVISION
Barksdale valves
5125 ALCOA AVENUE • LOS ANGELES 58 • CALIFORNIA

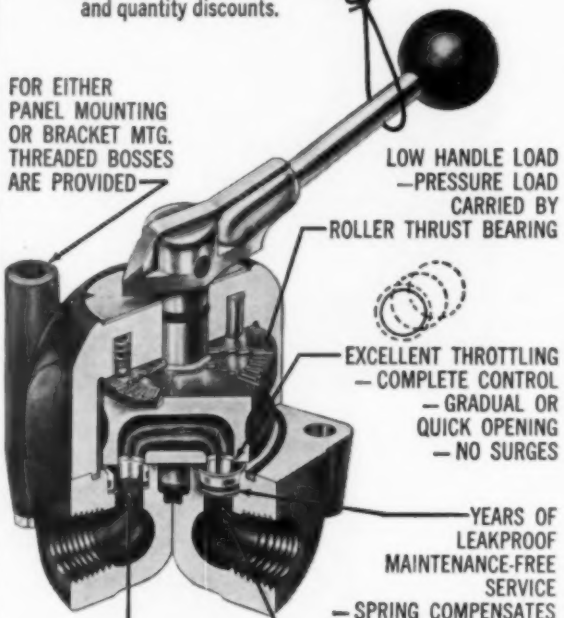
Circle **17** on Reader Service Card

NOW A "SHEAR-SEAL" VALVE for LESS than a spool valve

RATED FOR 3000 P.S.I. OIL SYSTEMS

$65.00
List Price*
for a ¾" valve

*Less the usual O.E.M. and quantity discounts.


FOR EITHER PANEL MOUNTING OR BRACKET MTG. THREADED BOSSES ARE PROVIDED
LOW HANDLE LOAD —PRESSURE LOAD CARRIED BY ROLLER THRUST BEARING
EXCELLENT THROTTLING — COMPLETE CONTROL — GRADUAL OR QUICK OPENING — NO SURGES
YEARS OF LEAKPROOF MAINTENANCE-FREE SERVICE — SPRING COMPENSATES FOR NORMAL WEAR
NO EXTERNAL LEAKAGE — PRESSURE IS CONFINED TO FLOW PASSAGES
MORE FLOW THRU UNOBSTRUCTED ROUND FLOW PASSAGES

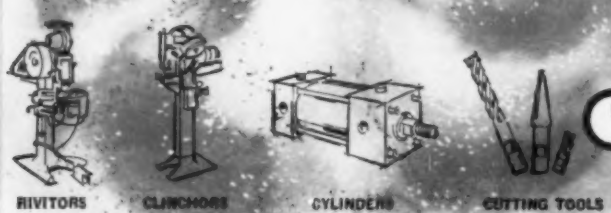
For complete data on this new valve and for information on all your valve requirements write for Standard Valve Catalog 60-61

CONTROL VALVE DIVISION
Barksdale valves
5125 ALCOA AVENUE • LOS ANGELES 58 • CALIFORNIA

Circle **18** on Reader Service Card

BIG NEWS

The T-J Spacemaker cylinder line is not now, nor ever has been, a probe into outer space. It is offered as a practically designed, research engineered and time tested product. Its Spacemaker feature (no tie-rods) and rugged construction gives greater strength, saves space and reduces costs in all power drive applications. The Spacemaker is available in a complete range of bore sizes and strokes, air or hydraulic, and contains many *plus features* and extras as STANDARD . . . NO EXTRA COST! Write Tomkins-Johnson, 2425 W. Michigan Ave., Jackson, Mich. for Bulletin #155-4 and for full particulars, today.



T-J TOMKINS-JOHNSON
JACKSON, MICHIGAN

CONTROLLED COMPRESSED AIR

PSC

3-WAY AIR CONTROL

REGULATOR
FILTER
LUBRICATOR

This **compact package unit** removes dirt, grit scale and moisture—prevents rusting and scoring—balances air surges—serves as shut-off valve.

Saves many dollars and valuable time by preventing unnecessary maintenance—down-time—and replacement of costly air tools and equipment.

REGULATOR

Accurate
Dependable
Positive Seating

Large orifice and piston maintains accurate pressure adjustment. Automatic bleed-off saves valuable set-up time. Balances pressure surges. Proper pressure assures peak performance.

FILTER

Dual Filtering
Cyclonic Action

Fine filtering removes dirt scale and condensate. Prevents damage due to dirty air. Permits air tools to operate at top efficiency. Less down-time, more production-time.

LUBRICATOR

Automatic Won't Flood

Automatic foglike oil mist protects and lengthens service life of air tools and equipment. Prevents costly repairs and replacement of air tools due to scoring and rusting. Assures long trouble-free service.

REGULATOR-FILTER

Accurately regulated, clean, moisture-free air assures a smoother, more efficient tool operation. Maintain peak production. Cut production costs.

Ask for Bulletin 80, listing and describing our complete line of Air Controls.

PERFECTING SERVICE CO.
332 Atlanta Ave. Charlotte 6, N. C.
Baltimore · Buffalo · Chicago · Cleveland · Camden · Los Angeles
New York · Providence · Montreal · Toronto · Canada

Circle **120** on Reader Service Card

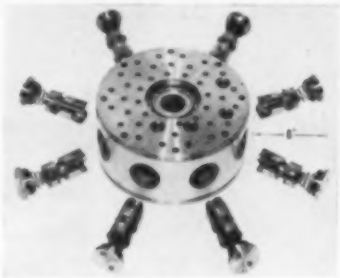
NEW PRODUCTS

Circle the numbers on the Reader Service post card for more information

SERVO MOTOR

For applications which require a control motor of extreme stiffness, high torque-to-inertia ratio, extremely fast response, and wide speed range with ultra-slow speed limits. Eight radial pistons drive motor through needle-bearing rollers acting on a two-lobed cam which encircles the hollow central spindle. Eliminates the need for intermediate gearing.

Specifications: 12" across by 6" thick; weighs 138 lbs. Operates at a recommended maximum pressure of 500-psi, with an effective speed range under servo control of 1/60,-000 rpm to 500 rpm. Delivers 3.52 in-lb torque at full capacity; efficiency of 98%. Reserves 100 rpm rotation in .0015 sec. and only .0006 of a revolution after the signal to reverse. Pistons are always under load, eliminating backlash.

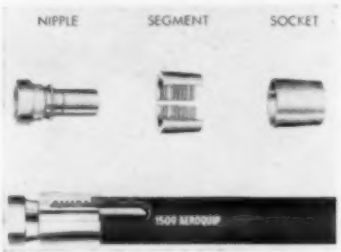


Designation: Acradrive-22.—*Cimtrol Div., Cincinnati Milling Machine Co., Cincinnati.*

Circle **300** on Reader Service Card

REUSABLE HIGH PRESSURE HOSE FITTING

Detachable, reusable fitting for use with high pressure, multiple wire braid hose assemblies in hydraulic and pneumatic applications, as well as fuel and lubrication systems. Fitting consists of three parts: A tapered steel socket is pushed over segments during assembly and forms a compression fitting. Two aluminum segments grip the hose reinforcement securely, and mate with the nipple for correct positioning. A steel nipple (without



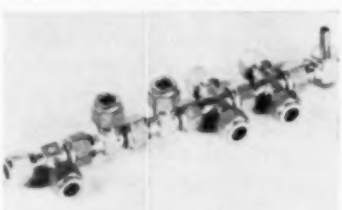
threads) fits into the hose, and does not cut the hose inner tube. Segments and sockets are the same for all types of end connections. The nipple is supplied in 10 different end connections for hose sizes ranging from ¾" to 2".

Designation: Iron Mike.—*Aeroquip Corp., Jackson, Mich.*

Circle **301** on Reader Service Card

ADAPTER TEES, ELBOWS, AND CROSSES

Adapter tees, elbows and crosses are now available to connect Swagelok tube fittings without using intermediate lengths of tubing. Complex manifolds can easily



be made. Such connections are leakproof, save space and reduce connection time. The tees and elbows can be perfectly aligned in the direction of the intended run.

Specifications: Available in sizes from ⅛" to 1" in machineable metals and plastics.—*Crawford Fitting Co., Cleveland.*

Circle **302** on Reader Service Card

Circle **157** →

Smooth output at lowest shaft speeds...

NEW WEBSTER HYDRAULIC MOTOR WITH INTEGRAL GEAR REDUCER

SPECIFICATIONS:

Models: 5, with a torque range from 39 to 142 inch pounds per 100 psi.
Input flow: Gpm at 1000 psi —
2.2 to 5.8 at 100 rpm output speed
4.9 to 15.5 at 300 rpm output speed
7.5 to 25.1 at 500 rpm output speed
Gear reduction: 4.65 to 1
Operating pressure: up to 2000 psi standard
Pumping gears: smooth-running spur involute — precision hobbed from alloy steel
Motor drive: free-floating internal spline
Seal: mechanical face-type on drive shaft
Porting: 1" NPT inlet and outlet standard, 1¼" "O" ring straight thread optional. ¼" NPT drain port.
Mounting: SAE-type "D" four-bolt mounting standard
Drive: Direct, gear or belt
Weight: 48 to 51 lbs.

This new Webster gear-type fluid motor combined with a planetary gear reducer was designed for high torque, low speed operations. High reduction ratio (4.65:1) assures smooth output at lowest shaft speeds!

The unit is extremely compact and provides stable, constant speed operation under varying loads. When used with a variable output flow divider, it becomes the high torque output element of an infinitely variable transmission. It is ideal for indexing, turning and transfer mechanisms; hydrostatic drives, winches, reels; turning or tilting units; batch mixers; driving elevators, conveyors — even earth augers.

The Webster motor-gear reducer has other important advantages: it may be used where it is impossible to use an electric motor because of explosion hazards... planetary gear assembly is lubricated by the hydraulic system..."straight through" drive between input and output shaft... mounts on an SAE standard, 4-bolt D size hydraulic pump mount. Drive is direct, gear or belt.

Your Webster Electric representative can tell you more about this interesting new hydraulic motor with integral gear reducer — or write direct for engineering detail sheet HY6-1.

OIL HYDRAULICS DIVISION
WEBSTER ELECTRIC
RACINE · WIS

Franklin adv. H129A

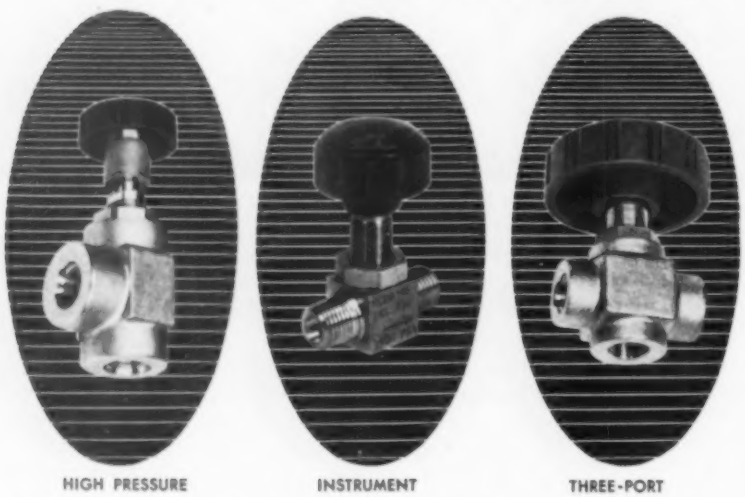
DO YOU HAVE PROBLEMS IN THE SMALL PIPING FIELD?

WE'D LIKE TO HELP YOU ... BUT WE NEED YOUR HELP

We're specialists in the small piping valve field... producing very high quality, precision-built valves for everyday as well as unusual applications. If you have a special problem that's giving you trouble, we'd like to hear from you... possibly we can help, either by suggesting one of our standard specialized valve items, or a slight modification. Please write, giving us complete details. DO IT TODAY!

ROBBINS VALVES ARE PRECISION MADE FOR PERFORMANCE!

DESIGNED TO SAVE YOU MONEY!



HIGH PRESSURE | INSTRUMENT | THREE-PORT

Here are three typically unique items in the Robbins Valve line. The high pressure valve operates up to 12,000 PSI, is pressure balanced, easily operated, panel mounts in one minute, serviced from front of panel. The instrument valve is really miniature... weighs only 0.31 lb., body is only ¾" square, operates from hi-vacuum to 3500 PSI, provides absolute shut-off, low torque, fine metering control, leakproof operation. The three-port valve simplifies stocking problems... can be used as globe or angle valve (with sealing plug), or with relief valve, pressure gauge or another line connection in third port.

Write TODAY for 16-page illustrated brochure in color! AND... if you have a special problem in valving of small piping... include all details. We'd like to help.

ROBBINS Aviation Inc.

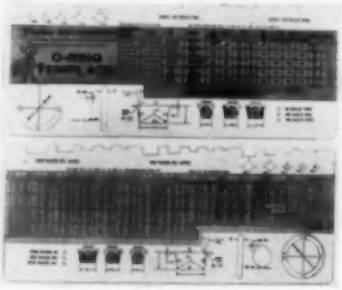
3817 S. Santa Fe Ave.
Los Angeles 58, California
LUdlow 9-5221

Circle **131** on Reader Service Card

NEW PRODUCTS

O-RING TEMPLATE

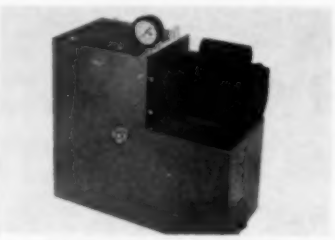
Drafting template to aid engineers, designers, and draftsmen in drawing cross sections and specifying O-rings, and O-ring grooves. Pocket size, semi-opaque, nonglare plastic. Carries dimensional and tolerance information, actual AN and other sizes, and other technical information.—*Parker Seal Co., Culver City, Calif.*



Circle **303** on Reader Service Card

HYDRAULIC PUMPING SYSTEM

Tank and pumping system for use in existing or OEM equipment where extreme compactness is required. Incorporates tank with external, horizontally mounted, totally enclosed ball-bearing motor, direct-coupled to a positive displacement gear pump.



Specifications: 8" x 18" x 16". ⅓ or ½ hp motor. Pump delivers up to 1½ gpm. Used with 150 to 200 S.S.U. hydraulic oil.

Designation: Power-Draulic.—*Bartsch Tool Corp., Skokie, Illinois.*

Circle **304** on Reader Service Card

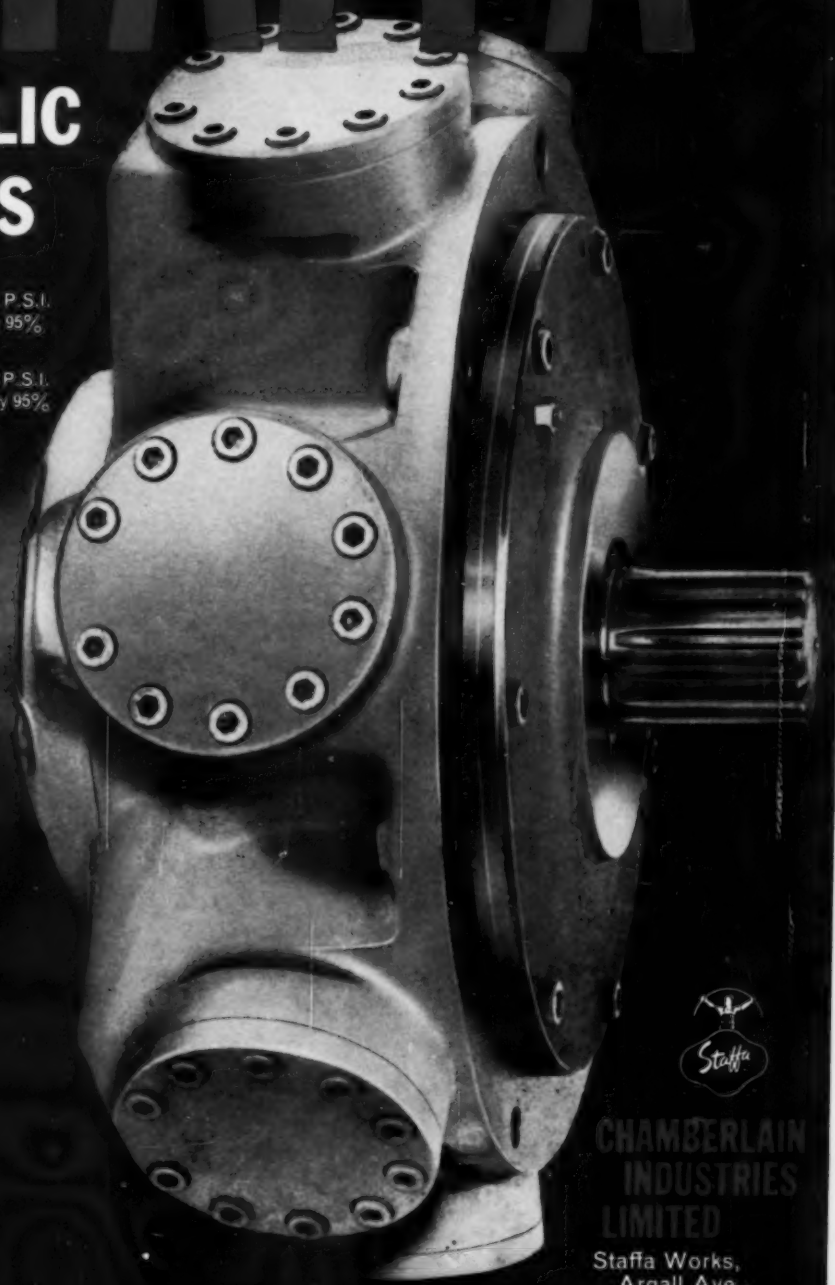
For more NEW PRODUCT reviews turn to page 148.

STAFFA

HYDRAULIC MOTORS

MARK 5 (as shown)
7 cyls. 6600 lbs. ft. Torque at 2000 P.S.I.
1-75 R.P.M. Reversible. Efficiency 95%

MARK 4
5 cyls. 4750 lbs. ft. Torque at 2000 P.S.I.
1-100 R.P.M. Reversible. Efficiency 95%



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Truck Mixers.
Extruding Machines.
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Derricks.
Dredgers.
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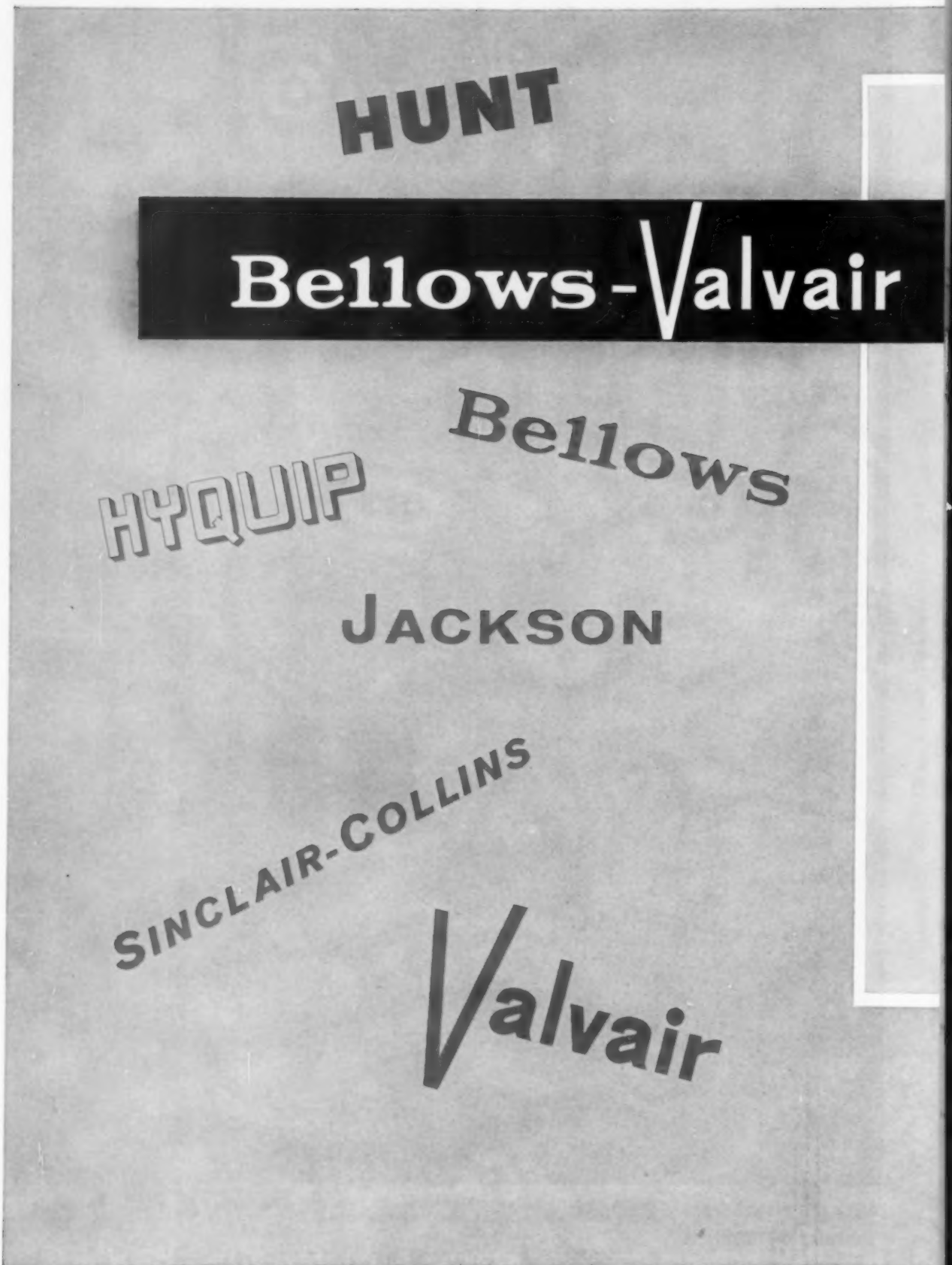
Steering.
Drills.
Cranes.
Locomotives.
Crawlers.
Ski Lifts.
Loaders.
Machine Tools.

CHAMBERLAIN INDUSTRIES LIMITED

Staffa Works,
Argall Ave.,
London E.10, England.

AMERICAN DISTRIBUTORS Double A Products Company, Manchester, Michigan (Hydraulic Motors)
Pedrick Tool & Machine Co. Inc., 3640 North Lawrence St. Philadelphia. 40. U.S.A. (Bending Machines)

CANADIAN DISTRIBUTORS Affiliated Engineering Equipment (1961) Ltd., 940 Cote de Liesse Road, MONTREAL 9, Quebec, CANADA. (Hydraulic Motors and Bending Machines)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NOW...ONE SOURCE

for pneumatics • hydraulics and related electronics

These famous trade names — Bellows . . . Valvair . . . Hunt . . . Sinclair-Collins . . . Hyquip . . . Jackson — have many things in common. Two are outstanding. These companies are known to industry as leading suppliers of pneumatic, hydraulic and electronic products. And, they all are part of International Basic Economy Corporation (IBEC).

To make it easier for you to select the most economical combination of related products best suited to your needs . . . to provide you with application engineering recommendations for entire control systems . . . to render unmatched service . . . these sources of specialized products have been combined into one engineering, sales and service organization — Bellows-Valvair.

The Bellows-Valvair Pneumatics Division will engineer, sell and service all Bellows, Valvair and Hunt products involving the use of air. The Bellows-Valvair Hydraulics Division will engineer, sell and service Hunt, Sinclair-Collins and Hyquip hydraulic products, as well as Berry-Dowty gear pumps and motors. The Bellows-Valvair Electronics Division will engineer, sell and service all related electronic devices.

Consolidation of all sales and service under the name Bellows-Valvair combines the knowledge and experience of over 300 design, production and field engineers. The resources of this group are at your service, ready to aid you in the engineering and application of pneumatics, hydraulics and electronics, to solve your production problems.

1196-C

New Bulletin FP-62 will give you more information on the divisional product groupings. For your copy, contact the field office near you (listed in the Yellow Pages and Thomas' Register, Volume IV), or write to Bellows-Valvair, Akron 9, Ohio, Dept. AH-1161.

Bellows-Valvair
Division of IBEC • AKRON 9, OHIO

These names assure you the best in pneumatic, hydraulic and electronic components
BELLOWS • VALVAIR • SINCLAIR-COLLINS • HUNT • HYQUIP • JACKSON ELECTRONICS

EXAMPLE: Schrader Square-end Cylinders not only have quality built into every part, but feature many extras. For instance, the unique cartridge-type bronze bearing assembly (A) is easily removed by releasing just one retaining ring—no need to dismantle the entire cylinder for bearing maintenance. Special "step" design cylinder seal (B) assures perfect alignment and positive seal without danger of gasket damage. Below surface cushion adjusting screws (C) are protected from damage but fully accessible. They lock to eliminate loosening due to vibration.

Interchangeable with all JIC cylinders, Schrader also provides a variety of mountings. Special bushings are available for bone-dry piston rod in hydraulic operation.

ANOTHER EXAMPLE: Schrader's new direct action Hydraulic Gauges without mechanical linkage (A) eliminate fatigue failure of internal parts. They can withstand 100% overload without damage to accuracy, and are triple-damped (B) to eliminate indicator oscillation from pump pulses, surges, or shock that would damage other types. Can be maintained and calibrated easily in the field. PSI pressure ranges 0-500, -1500, -3000, and -5000.

This new Schrader catalog is available at your Schrader distributor, who is stocked with the complete range of sizes and types of Schrader air circuitry products. Consult the Yellow Pages or write Schrader.

FULL LINES OF QUALITY AIR CIRCUIT COMPONENTS • OFF-THE-SHELF SERVICE AND INFORMATION FROM YOUR NEARBY DISTRIBUTOR • STAFFED WITH AIR CIRCUIT EXPERTS • CONSULT YELLOW PAGES OR WRITE FOR HIS ADDRESS

Schrader®
a division of SCOVILL

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Division of Scovill Manufacturing Co., Inc.
456 Vanderbilt Ave., Brooklyn 38, N. Y.

NEW LITERATURE

Circle the numbers on the Reader Service post card for free copies

ROTARY PRESSURE SWITCHES

Miniature, lightweight switches that actuate under pressures of 6 to 600-psig and operate to pressures of 3000-psig are shown. Ratings are 5 amps resistive, 3 amps inductive at 30 vdc, and 5 amps at 125/250 vac. Not affected by "g" loading. Accept excessive pressures and pressure fluctuations. Less costly than diaphragm units. Cam converter assembly triggers a microswitch; also permits ganging of up to four switches, each capable of being triggered to operate at different pressure levels. Model RPS 17—*IMC Magnetics Corp., Phoenix, Arizona.*

Circle **400** on Reader Service Card

4500-PSI VALVES

Comprehensive line of 2-, 3-, and 4-way valves for air, gas, water, and hydraulic oils in pressure ratings up to 4500-psi are thoroughly described in this brochure. Line includes manually operated, solenoid-operated, and pilot-operated pressure and flow control valves. Valve manifold units, with or without subplate mounting, are shown with power units for grinding, lathe, and plastic molding press control. Includes a brief history of the development and progress of the German manufacturer.—*Herion Incorporated, Valley Stream, New York.*

Circle **401** on Reader Service Card

QUICK-CONNECT COUPLINGS

Catalog C-2002 covers a complete line of aircraft quick-connect couplings with 3000-psi proof pressure. The 1-inch coupling has less than 1 psi pressure drop at 10 gpm. An indicating pin lets the operator feel when the coupling is connected. Holds pressure or vacuum. Catalog C-3001 describes the industrial quick-connect couplings made in sizes from ¼" to 3". A third catalog, C-2101 describes a quick-connect coupling that connects and disconnects with no air inclusion and a maximum of 0.1 cc spillage. *Jack & Heintz Div. Siegler Corp., Cleveland.*

Circle **402** on Reader Service Card

HYDRAULIC CLAMPS

Booklet shows how hydraulic clamping saves over-all machining effort. Assemblies and components of clamping fixtures detailed with tables and diagrams. Some advantages mentioned are fully equalized system, no workpiece distortion, speed, ease. Multi-point clamping in any position. Up to 120 cylinders actuated simultaneously. Closed circuit system. Dial reading if desired. Catalog No. 2—*Newton Hydraulic Tooling Co., Auburn, Mass.*

Circle **403** on Reader Service Card

SILICONE RUBBER

Fifty-six page booklet covering silicone rubber from supply source to test ratings and specifications. Includes a section explaining such terms as durometer, elongation, and tensile strength. Deterioration of silicones by swelling, softening, and loss of physical characteristics such as tensile, and resiliency is discussed in the section on solvent and oil resistance. Many charts and photographs. *The Uses and Abuses of Silicone Rubber.—Mechanical Rubber Products Co., Warwick, N. Y.*

Circle **404** on Reader Service Card

NON-SKIVE HOSE

Design and performance data on two basic types of new, non-skive hydraulic rubber hose. R301 hose is a single-wire, reinforced design for medium pressure service; R302 hose is a high pressure design with two layers of wire braid reinforce-

Continued on next page

Circle **61** on Reader Service Card

NEW LITERATURE

ment. End fittings include JIC swivel, SAE female swivel and male pipe terminators. Hose and end fittings available in bulk or as complete assemblies with end fittings attached. For bulk hose users, a tool is included for attaching fittings to Teflon as well as stock hose. Catalog R300—*Titeflex, Inc., Springfield, Mass.*

Circle **405** on Reader Service Card

MIDGET SOLENOID VALVES

Catalog sheets describing new 2-, 3-, and 4-way solenoid valves. Includes line of midget and packless valves. General ordering and discount information. *Condensed Valve Supplement—Automatic Switch Co., Florham Park, N. J.*

Circle **406** on Reader Service Card

VALVED COUPLINGS

Line of quick connect/disconnect couplings includes the all-purpose "H" coupling for positive pressure uses; the "IH" for impact air tools; the "E" for high pressure, vacuum, and extremely low pressure applications; the "T" for hard-to-handle fluids; the "ES" for non-spray uses; and the "19" valved coupling for aircraft and missile applications. Complete dimensional and weight data. Working, proof, and burst pressures. Disconnect spillage, maximum flow, and pressure drop data. Exhaustive tables. Ordering info. Catalog 60A 62 pages.—*Snap-Tite, Inc., Union City, Penn.*

Circle **407** on Reader Service Card

BALL VALVES AND ACTUATORS

Brochure covers line of compact, reliable ball valves for use in hydraulic oil and air service systems. Valves feature a torsionally flexible seat seal and are positive sealing throughout the full range of working pressures. Temperature range 28 F to 200 F. Design test pressure of low pressure valve to 3000 psi. Working pressure of high pressure valve to 4500 psi. Also covered are compact actuators for hand or hydraulic operation of these ball valves.—*Electric Boat Div., General Dynamics Corp., Groton, Conn.*

Circle **408** on Reader Service Card

HEAT EXCHANGERS

Construction features give improved performance and reliability in a variety of applications. Sizes, dimensions, and weights are listed for one-, two-, and four-pass exchangers with shell diameters from 3¼" to 8¼" and lengths from 1' 4¾" to 6' 7". Bulletin F—1161—*Basco Inc., North Tonawanda, N. Y.*

Circle **409** on Reader Service Card

SHOCK ABSORBERS

Standardized shock absorbers in over 60 models built to exacting specifications now available in bore diameters 2" and 4", strokes to 8" in 1" increments. Capable of loads to 25,000 foot-pounds, and velocities to 150 feet/sec. Front and rear flange and/or foot mountings standard; others to order.—*Ellis Fluid Dynamics Corp., Skokie, Ill.*

Circle **410** on Reader Service Card

For more reviews of FREE LITERATURE turn to page 156.

BHEW

Hydraulic Cylinders

- Basic Designs
- Specific Adaptations
- Superior Quality
- Application Engineering

BHEW SINGLE-ACTING GENERAL-PURPOSE CYLINDERS (1500 PSI PISTON STYLE SERIES) are designed around standard components but custom-built to suit *your* application. They're available in a variety of mountings (pin eye is standard) with adjustable or non-adjustable rod ends, with or without rod ends.

• Self-adjusting "U" cup seal on pistons • Self-adjusting rod wipers • Honed steel barrel, high-tensile, hard chrome-plated rod ends • Packings available for extreme high and low temperatures and most non-inflammable fluids.

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BENTON HARBOR ENGINEERING WORKS, INC.
622 Langley Avenue St. Joseph, Michigan

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YOU REDUCE COST WITHOUT SACRIFICING QUALITY

when you specify B&W Lectrosonic J.I.C. Hydraulic Line Tubing

J.I.C. Standards for hydraulic fluid line applications now permit the use of welded or seamless steel tubing on an equivalent basis. B&W Lectrosonic® welded carbon steel tubing meets all such J.I.C. Standards—and has been proved by 6 years of rugged B&W field testing. What's more, B&W Lectrosonic tubing is produced under the most rigid quality control procedures in the industry. Tests are made before, during and after manufacture. The key phase: 100% ultrasonic inspection of the weld in line production. The result: superior electric-resistance welded tubing that does the job of seamless while it maintains the low cost advantages of welded.

See how B&W Lectrosonic tubing can meet your hydraulic line requirements. Just call your B&W District Sales Office or write for Bulletin T-435. The Babcock & Wilcox Company, Tubular Products Division, Beaver Falls, Pennsylvania.

B&W

THE BABCOCK & WILCOX COMPANY

TUBULAR PRODUCTS DIVISION

TA-1009-M

Seamless and welded tubular products, solid extrusions, seamless welding fittings and forged steel flanges—in carbon, alloy and stainless steels and special metals

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fast delivery
uniform quality
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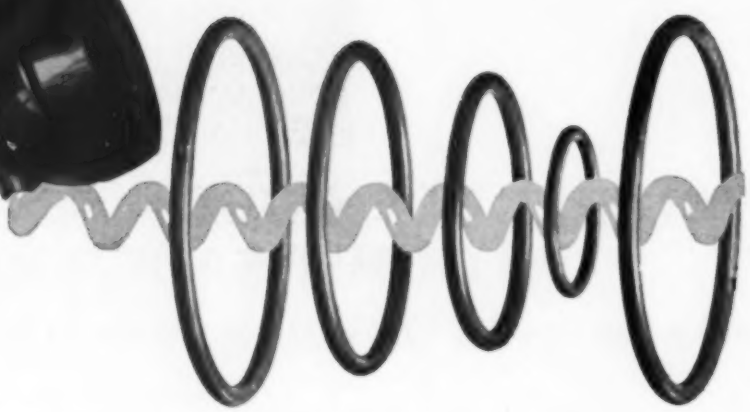

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Division, Federal-Mogul-Bower Bearings, Inc.
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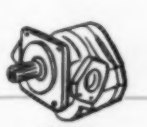

PUMPS

VALVES

MOTORS

Circle **79** on Reader Service Card

BEST BUY IN THE COMPACT FIELD TODAY

NEW WATTS

FILTER – REGULATOR – LUBRICATOR

You know what it's like to design a system and then find oversized components driving weight and costs up.

But no more. Now you can specify this compact Watts assembly for applications where (1) space is limited or (2) you have low flow requirements.

You don't sacrifice a thing! Dependable Watts filter has 20 micron porous bronze element. Exclusive Watts by-pass principle gives optimum lubrication at flow rates from .2 to 15 CFM with negligible pressure drop. Fill plug and oil feed adjustment are interchangeable front to rear. Maximum pressure is 150 PSI. Two sizes — ⅛" and ¼".

Write for complete information. Watts Regulator Company, Industrial Division, Lawrence, Massachusetts

Hydraulics & Pneumatics
NOVEMBER 1961

THE SHAPE OF SEALS

• By TOBI GOLDOFTAS, *Associate Editor*

PICKING A PACKING (or seal if you prefer) is a matter of specific application: what fluid it must seal, at what pressure and temperature, in what component. Many other factors like wear, friction, cost also complicate the choice, and final seal designs are often arrived at only after a long development program.

The list of seal shapes and materials is a long and growing one—each type has been engineered to meet specific requirements. To help you in one part of the selection job, the following pages chart seal and wiper shapes, showing what's available. These charts have been limited to pressure sealing types for static and reciprocating applications. Pipe thread sealing devices which have also been effective include thread tape, locknut with Teflon insert, and pipe dope.

A list of manufacturers has been included with numbers following each company name to indicate seal type. These numbers correspond to seals in the charts. Further information on seal selection is given in the January Designer's Guide of HYDRAULICS & PNEUMATICS and the 1962/63 FLUID POWER HANDBOOK & DIRECTORY.

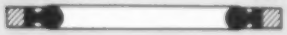
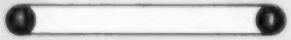
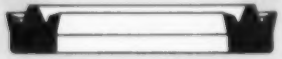
Some seal shapes require auxiliary devices such as back-up rings for O-rings, male and female adapters for V-rings, and springs to load Teflon seals at low pressure. The use of these devices and other techniques for designing seal grooves, glands, and installation will be the subject of a future article.

ELASTOMERIC & LEATHER SEALS

	APPLICATION	MEDIUM				MATERIAL AND TEMPERATURE RANGES														MAXIMUM PRESSURE PSI*					SURFACE FINISH REQ'D. MICRO INCHES	OD SIZE RANGE - INCHES**				
	STATIC	DYNAMIC	AIR	OIL	WATER BASE FLUIDS	PHOSPHATE ESTER FLUIDS	ACRYLON, HYCAR (-40 TO 350F)	BUNA N (-65 TO 300F)	BUNA S (-65 TO 300F)	BUTYL (-65 TO 250F)	FAB. REIN. RUB. (-40 TO 350F)	KEL-F (-20 TO 350F)	LEATHER (-65 TO 250F)	NATURAL RUBBER (-65 TO 212F)	NEOPRENE (-65 TO 400F)	SILICONE (—130 to 400 F)	TEFLON (-120 TO 500F)	THIOKOL (-65 TO 170F)	URETHANE (-40 TO 212F)	VITON (-30 TO 500F)	500	1500	2000	3000	5000 AND OVER	16 OR LESS	16 OR MORE	½ TO 1	1 TO 3	3 TO 6	6 TO 10	OVER 10
1		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●	3	4	4	4,5	5,6	●	●	●	●	●	●
2		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●
3		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
4		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
5		●	●	●	●	●	●	●	●	●	●	●	●				●				3	4	4	5	5	●		●	●	●	●
6	●		●	●	●	●	●	●	●	●		●			●		●		●	●		2	3	4		●		●	●	●	●
7		●	●	●	●	●		●			●				●		●			●	2	2	3	4	5,6	●		●	●	●	●
8		●	●	●	●	●		●			●				●		●			●	2	2	3	4	5,6	●		●	●	●	●
9	●		●	●	●	●	●	●	●	●		●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●

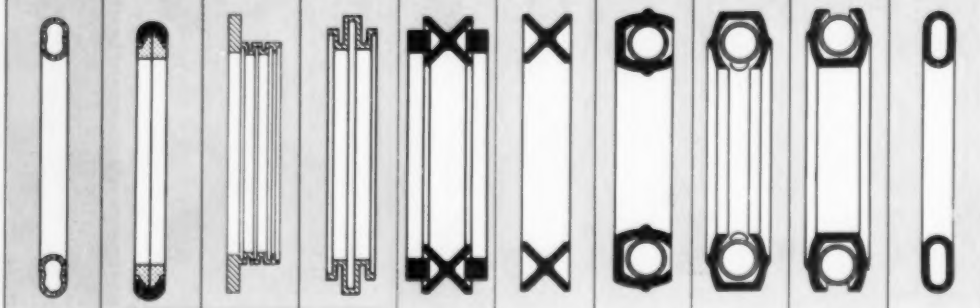
| | | |

ELASTOMERIC & LEATHER SEALS CONT'D

		APPLICATION		MEDIUM				MATERIAL AND TEMPERATURE RANGES												MAXIMUM PRESSURE PSI					SURFACE FINISH REQ'D, MICRO INCHES		OD SIZE RANGE, INCHES				
		STATIC	DYNAMIC	AIR	OIL	WATER BASE FLUIDS	PHOSPHATE ESTER FLUIDS	ACRYLON, HYCAR (-40 TO 350F)	BUNA N (-65 TO 300F)	BUNA S (-65 TO 200F)	BUTYL (-65 TO 250F)	FAB. REIN. RUB. (-40 TO 250F)	KEL-F (-20 TO 350F)	LEATHER (-65 TO 250F)	NATURAL RUBBER (-65 TO 212F)	NEOPRENE (-65 TO 400F)	SILICONE (-130 to 400 F)	TEFLON (-120 TO 500F)	THIOKOL (-65 TO 170F)	URETHANE (-40 TO 212F)	VITON (-20 TO 500F)	500	1500	2000	3000	5000 AND OVER	16 OR LESS	16 OR MORE	½ TO 1	1 TO 3	3 TO 6	6 TO 10	OVER 10
23		●		●	●	●	●		●		●				●	●	●				●	●	●	●	●	●		●	●			
24		●		●	●	●	●		●		●				●	●	●				●	●	●	●	●	●	●	●	●	●	●	●
25		●		●	●	●	●		●		●				●	●	●				●	●	●	●	●	●	●	●	●	●	●	●
26		●		●	●	●	●	●	●	●	●				●	●	●				●	●	●	●	●	●	●	●	●			
27		●		●	●	●									●					●		●	●	●	●							
28		●	●	●	●	●	●		●			●				●	●	●			●	●	●	●	●		●		●	●	●	●

	APPLICATION	MEDIUM	MATERIALS		MAXIMUM PRESSURE PSI	SURFACE FINISH REQ'D, MICRO INCHES	OD SIZE RANGE, INCHES
			METAL	COATING			

METALLIC SEALS



38	37	36	35	34	33	32	31	30	29	
●			●	●	●		●	●	●	STATIC
	●	●		●		●				DYNAMIC
●	●	●	●	●	●	●	●	●	●	AIR
●	●	●	●	●	●	●	●	●	●	OIL
●	●	●	●	●	●	●	●	●	●	WATER BASE FLUIDS
●		●	●	●	●	●	●	●	●	PHOSPHATE ESTER FLUIDS
				●	●				●	ALUMINUM
	●									BABBITT
	●									BAKELITE
						●	●	●		BERRYLIUM
	●								●	BRASS
	●									BRONZE
						●	●	●	●	COPPER
●		●	●	●	●				●	INCONEL X
●		●	●	●	●	●	●	●	●	STAINLESS STEEL
						●	●	●		FEP
				●	●					FLAME PLATED
			●			●	●	●	●	KEL-F
									●	POLYETHYLENE
			●	●	●				●	SILVER
			●			●	●	●	●	TEFLON AND TEFLON FILLED
●									●	500
●									●	1500
	●								●	2000
	●	●							●	3000
			●	●	●	●	●	●	●	5000 AND OVER
			●	●	●	●	●	●	●	16 OR LESS
●										16 OR MORE
●	●		●	●	●	●	●	●	●	½ TO 1
●	●		●	●	●	●	●	●	●	1 TO 3
●	●		●	●	●	●	●	●	●	3 TO 6
●	●		●	●	●	●	●	●	●	6 TO 10
●	●		●	●	●	●	●	●	●	OVER 10

INCHES

METALLIC SEALS CONT'D

	APPLICATION		MEDIUM					MATERIALS																MAXIMUM PRESSURE PSI					SURFACE FINISH REQ'D, MICRO INCHES	OD SIZE RANGE, INCHES				
								METAL										COATING																
	STATIC	DYNAMIC	AIR	OIL	WATER BASE FLUIDS	PHOSPHATE ESTER FLUIDS	ALUMINUM	BABBITT	BAKELITE	BERRYLIUM	BRASS	BRONZE	COPPER	INCONEL X	STAINLESS STEEL	FEP	FLAME PLATED	KEL-F	POLYETHYLENE	SILVER	TEFLON AND TEFLON FILLED	500	1500	2000	3000	5000 AND OVER	16 OR LESS	16 OR MORE	½ TO 1	1 TO 3	3 TO 6	6 TO 10	OVER 10
39	●		●	●	●	●									●													●	●	●		
40	●		●	●	●	●								●	●			●		●	●					●		●	●	●	●	●
41	●		●	●	●	●									●					●						●		●	●	●		
42	●		●	●	●	●	●														●	●	●	●	●			●	●	●	●	●
43		●													●						●					●			●	●	●	●	●
44	●		●	●	●	●								●	●					●						●		●	●	●		
45	●		●	●	●	●								●	●					●						●		●	●	●		
46		●	●	●	●	●						●			●						●	●	●	●	●	●	●	●	●	●	●	●
47		●	●	●	●	●						●			●						●	●	●	●	●	●	●	●	●	●	●	●
48		●	●	●	●	●						●			●						●	●	●	●	●	●	●	●	●	●	●	●

WIPERS

	APPLICATION		MEDIUM					MATERIALS																ID SIZE RANGE, INCHES									FACE FINISH REQ'D, MICRO INCHES	
	STATIC	DYNAMIC	AIR	OIL	WATER BASE FLUIDS	PHOSPHATE ESTER FLUIDS	BRASS	BRONZE	BUNA N	BUNA S	BUTYL	ELASTOMER AND METAL	FABRIC	FELT	KEL-F	LEATHER	NATURAL RUBBER	NEOPRENE	NYLON	TEFLON	URETHANE	¼ TO 1	1 TO 3	3 TO 6	6 TO 10	OVER 10	16 OR LESS	16 OR MORE					
49		●	●	●					●								●	●				●	●				●						
50		●	●	●	●	●			●	●	●	●			●	●	●	●		●		●	●	●	●	●	●	●					
51		●	●	●	●	●			●	●	●	●		●	●	●	●	●		●		●	●	●	●	●	●	●					
52		●	●	●					●		●							●						●	●								
53		●	●	●	●	●			●	●	●	●	●		●	●	●	●	●	●		●	●	●	●	●	●	●					
54		●	●	●	●				●	●	●				●			●		●		●		●									
55		●	●	●			●	●	●			●								●		●		●									
56		●	●	●	●	●							●																				
57		●	●	●	●	●			●	●	●	●			●			●		●	●	●	●	●	●	●	●	●					
58		●	●	●	●	●			●	●	●	●			●			●		●	●	●	●	●	●	●	●	●					

These manufacturers can supply detailed information on their seals and wipers.

Numbers correspond to seal shapes in charts

Advanced Products Co.
38

Aero Gasket Corp.
8, 21

George Angus & Company, Ltd.
1, 2, 3, 4, 9, 13, 20, 53

The Auburn Mfg. Co.
1, 2, 3, 4, 9, 20, 46, 47, 48

Auto-Diesel Piston Ring Co.
46, 47, 48

B. A. L. Ltd.
1, 2, 3, 4, 7, 8, 9, 52

Bearings, Inc.
1, 2, 3, 9

Bellofram Corp.
21, 22

Chicago-Allis Mfg. Corp.
1, 2, 3, 4, 5, 9, 21, 50, 51, 53

Chicago Rawhide Mfg. Co.
1, 2, 3, 4, 6, 9, 20, 21, 46, 47, 48, 57, 58

Cook Airtomic Div.
1, 3, 4, 29, 46, 47, 48

Crane Packing Co.
1, 2, 3, 4, 9, 53

Darling Valve & Mfg. Co.
3

Diaphragm Industries, Inc.
21, 22, 23, 24

Disogrin Industries, Inc.
1, 2, 3, 4, 9, 20, 21, 27

Dixon Corp.
1, 2, 3, 4, 9, 46, 47, 48

Dowty Group Ltd.
1, 2, 3, 4, 5, 9, 26

D.S.D. Mfg. Co.
40

Excelsior Leather Washer Mfg. Co., Inc.
1, 2, 3, 4, 9, 46, 47, 48

France Packing Co.
46, 47, 48

Garlock, Inc.
1, 2, 3, 4, 9, 46, 47, 48

Goshen Rubber Co., Inc.
2, 3, 4, 9, 20

Greene Tweed & Co.
1, 2, 3, 4, 9, 10, 11, 53

Grover Piston Ring Co., Inc.
46, 47, 48

Hadbar, Inc.
1, 2, 3, 4, 9, 46, 47, 48

Hall and Hall Ltd.
1, 2, 3, 4, 9, 18, 19, 46, 47, 48

Halogen Insulator & Seal Corp.
1, 2, 3, 4, 9, 20, 29, 30, 31, 46, 47, 48, 54

Haskel Engineering & Supply Co.
1, 2, 3, 4, 5, 9, 41, 42, 43, 44, 45

E. F. Houghton & Co.
1, 2, 3, 4, 9, 53

Hydraulic Accessories Co.
37, 46, 47, 48, 56

Hydrodyne Corp.
4, 35, 36

International Packings Corp.
1, 2, 3, 4, 9

Johns-Manville
1, 2, 3, 4, 5, 7, 8, 9, 12, 28, 56

Koppers Co., Inc.
4, 9, 46, 47, 48

Linear, Inc.
1, 2, 3, 4, 5, 9, 21, 53

C. W. Marsh Co.
1, 2, 3, 4

Martin Merkel K. G.
1, 2, 3, 4, 5, 7, 8, 9, 11, 19, 20, 29, 30, 31, 32, 33, 42, 46, 47, 48, 49, 53, 54

Minnesota Rubber Co.
9, 13, 46, 47, 48

National Seal Div.
9, 27

Nichols Engin. Inc.
9

Page Belting Co.
1, 2, 3, 4, 9

Parker Seal Co.
9, 23, 24, 25

Perflex, Inc.
1, 2, 3, 4, 9, 21, 53, 54

Pioneer Oilsealing Ltd.
2, 3, 4, 9, 14, 20, 46, 47, 48

Plastic & Rubber Prod. Co.
1, 2, 3, 4, 9

Precision Rubber Prod. Corp.
9, 26

Raybestos-Manhattan, Inc.
1, 2, 3, 4, 9, 46, 47, 48

Reid Enterprises, Inc.
1, 2, 3, 4, 9, 30, 31, 32

Searle Leather & Packing Co.
1, 2, 3, 4, 5, 9

Servotronics, Inc.
1, 4, 9, 39, 46, 47, 48

W. S. Shamban & Co.
1, 2, 3, 4, 9, 53

Sparta Mfg. Co.
1, 2, 3, 4, 9, 46, 47, 48

Stillman Rubber Co.
9, 23, 24, 25, 26

Super Oil Seals & Gaskets Ltd.
1, 2, 3, 4, 5, 9, 49, 50, 51, 53

Tanner Engineering Co.
17

Ronald Trist & Co., Ltd.
1, 2, 3, 4, 7, 9, 15, 16, 20, 21

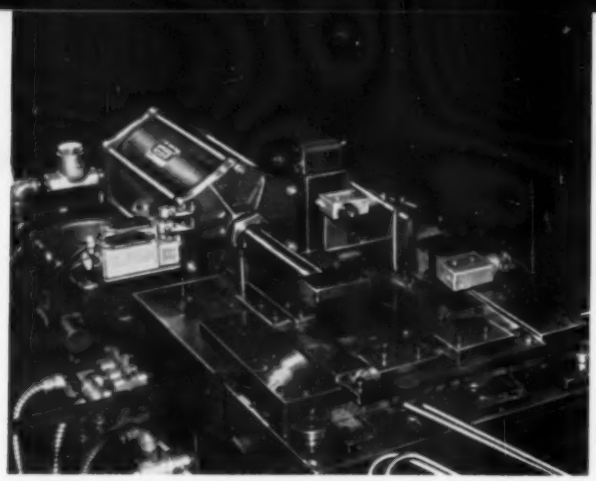
Albert Trostel Packings Ltd.
1, 2, 3, 4, 9

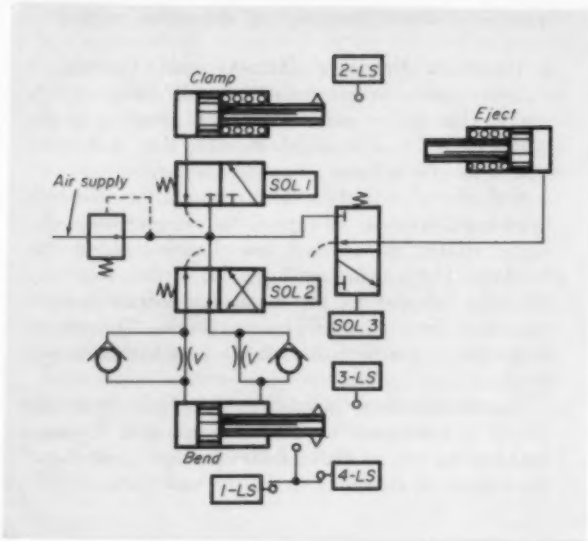
United Aircraft Products, Inc.
4, 9, 29

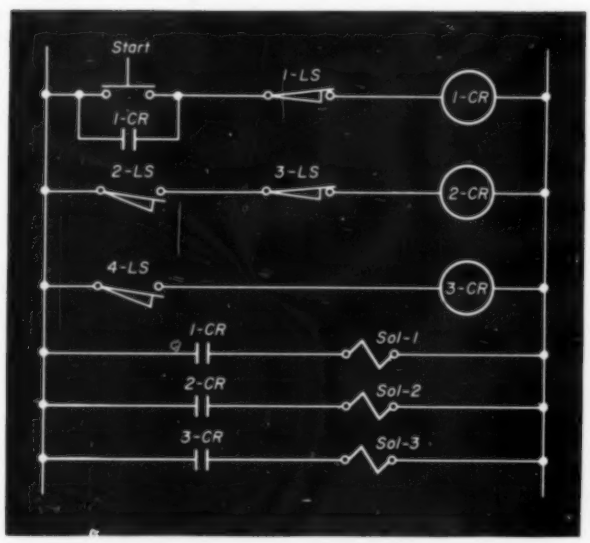
James Walker Packing Co., Inc.
1, 2

Westinghouse Air Brake Co.
3

E. B. Wiggins Oil Tool Co., Inc.
33, 34







Meter-out air circuit times bending press

THE overall cycle time on this bending press is regulated by two adjustable flow control valves. One meters air out of the cylinder's rod end during its work stroke. The other controls the cylinder's return speed by metering air from its blind end. Limit switches, actuated during the cylinder's stroke, energize and de-energize relays to sequence the circuit.

• **Automatic Sequencing**—The press was built by Barridon Corp., Hartford, Conn. to form burner grills by making three hairpin bends in solid steel rod. The operator places the rod in position and presses the START button. The machine clamps, bends, and ejects the finished grill.

Pressing the START button energizes relay 1-CR which actuates Solenoid 1 to extend the CLAMP cylinder. Limit switch 2-LS closes, energizing relay 2-CR, when the rod is clamped. Relay 2-CR energizes solenoid 2, shifting the 4-way valve to extend the BEND cylinder. Limit switch 3-LS, actuated at the end of the BEND cylinder's work stroke, de-energizes relay 2-CR and Solenoid 2. The BEND cylinder retracts. Near the end of its return stroke, it momentarily trips limit switches 1-LS and 4-LS. These limit switches trip only on the cylinder's return stroke. Limit switch 1-LS de-energizes relay 1-CR, releasing the clamp cylinder. Limit switch 4-LS momentarily energizes solenoid 3 actuating the EJECT cylinder to eject the finished grill. ▼▼▼

This article was prepared from information furnished by A. Schrader's Son, Division of Scovill Mfg. Co., Inc., Brooklyn, N. Y.

How to control air cylinder speed

• By P. L. BRADY, *Pneumatics Group Engineer, General Dynamics Corp., San Diego.*

Compressibility of air can be used to advantage in providing accurate cylinder control. Air pressure applied to the rod end of a cylinder helps control the stroke while the cylinder extends. Energy in compressed air is also valuable in absorbing inpact at the end of the cylinder's stroke.

HYDRAULIC cylinders have oil on both sides of the piston to control their motion. Even if flow is stopped and then started again, the piston has enough fluid on both sides for adequate control. In pneumatic cylinders, where speed is controlled by metering air out, if there is a time delay during the cycle, the piston's backpressure dissipates. This leaves no control of the piston's velocity or impact at end of stroke.

A type of circuit suited for controlling pneumatic systems is called a run-around circuit. It uses air pressure at the rod end of the cylinder to control cylinder extension. There are two types of run-around systems: constant pressure, and expansion circuits.

• **Constant Pressure Run-Around Circuit**—A constant pressure run-around circuit is shown in Figure 1. This circuit maintains system pressure at the cylinder's rod end during both retraction and extension, and uses a 3-way, 2-position valve.

With the valve in the retract position, the cylinder's head end is vented. To extend the cylinder, the valve shifts, closing the exhaust and directing air to the head end of the cylinder. A portion of this air comes from the rod end via the run-around circuit and the rest from the supply or pressure source. This circuit is similar to a differential circuit in a hydraulic system.

The maximum cylinder extension force from this circuit is determined by the piston rod area. Pressure build-up to extend the cylinder is rapid because of the volume of air stored in the rod end.

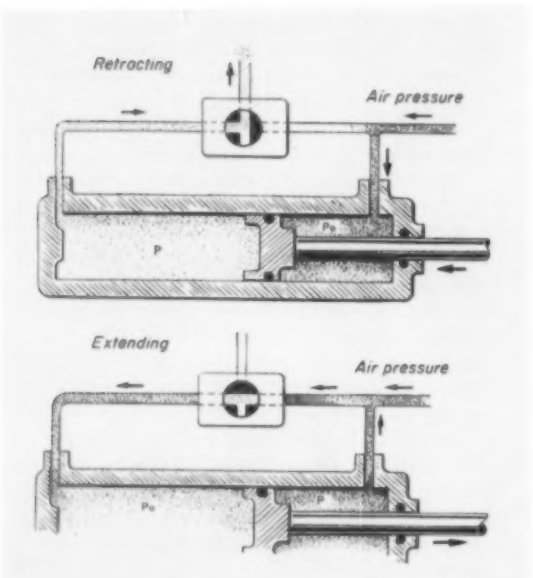


FIG. 1. CONSTANT PRESSURE RUN-AROUND CIRCUIT is recommended in systems where retracting load is high and extending load is moderate.

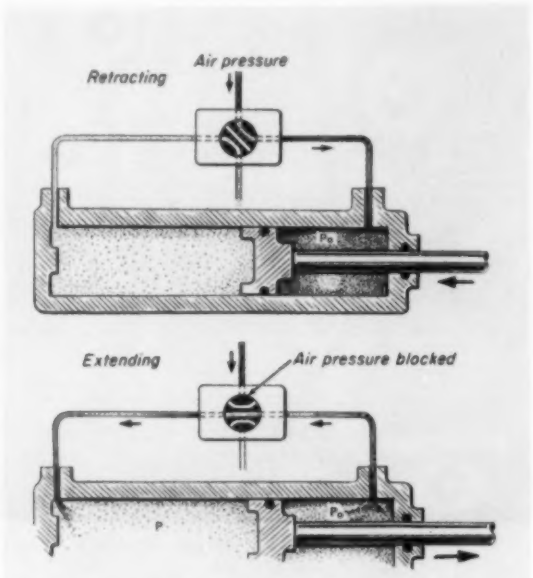


FIG. 2. EXPANSION RUN-AROUND CIRCUIT is used when retraction load is high and extension load is low.

and impact

• **Expansion Run-Around Circuit**—A 4-way, 2-position valve controls the cylinder in Figure 2. With the cylinder retracted, the circuit is similar to the constant-pressure run-around circuit. To extend the cylinder, the valve blocks the pressure and exhaust ports and allows air stored in the rod end to expand into the head end, extending the cylinder.

The initial acceleration is the same as in the constant pressure run-around circuit. However, pressure drops as the piston extends. The final pressure is determined by the volumetric relationship of the cylinder's rod and head ends. This system uses less air, because the cylinder is extended with energy stored in the rod end.

Each of these cylinder circuits has a specific application. The choice of circuit is determined by the type and magnitude of the load. When the work load is high during extending and retracting, a conventional 4-way valve circuit is best. If the retracting load is high, and the extending load is moderate, the full-pressure, run-around is preferable. Where retraction load is high and extension load is low, the expansion run-around is recommended.

• **Buffers**—Methods of snubbing are determined by the requirements of the system and the maximum allowable impact loads.

Two types of cylinder buffers used at the end of the extension stroke to limit cylinder impact are shown in Figure 3. A force exceeding the design impact deflects the buffer. This deflection depends on the amount of energy absorbed. The higher the impact force, the greater the buffer deflection. Air supply to the buffer controls rebound. Buffers may be connected to the system supply directly or through an orifice.

• **External Snubbers**—Two external snubbers which control the bottoming velocity of a cylinder at the end of the retraction cycle are shown in Figure 4.

In the expansion snubber, both sides of the piston are at system pressure. The differential area of the piston head end extends the snubber after each cylinder stroke. The amount of snubbing is determined by the size of the orifice between the two chambers. As the cylinder strikes the snubber rod, its impact retracts the piston. Air in the rod end expands, and air in the head end remains at system pressure due to the free flow out of the chamber. The orifice allows a fixed quantity of air flow into the lower chamber. This flow is determined by orifice and pressure differential across the orifice.

In the compression snubber, the lower chamber is held at system pressure and air in the upper chamber is compressed. A balance rod reduces force holding the snubber extended.

Pneumatic snubbers are very sensitive to cylinder velocity. The faster the piston is moving at the time of impact, the greater the snubbing action. ▼▼▼

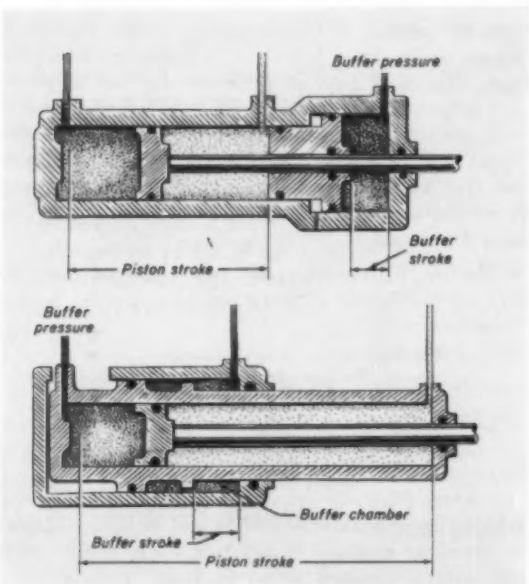


FIG. 3. CYLINDER STROKE IS CUSHIONED by internal buffer (a) or external buffer (b). External buffer is used on long stroke cylinders.

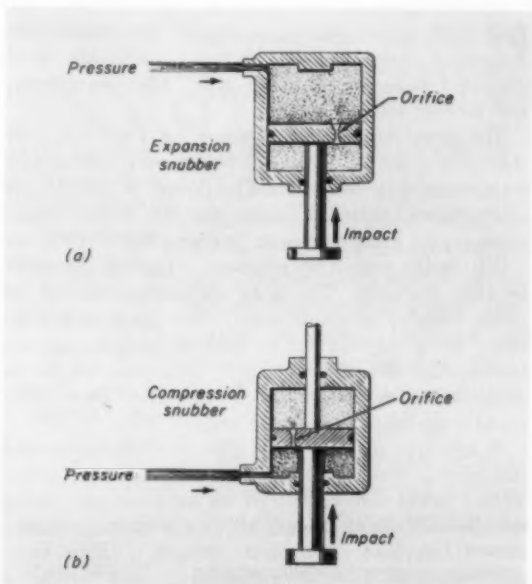
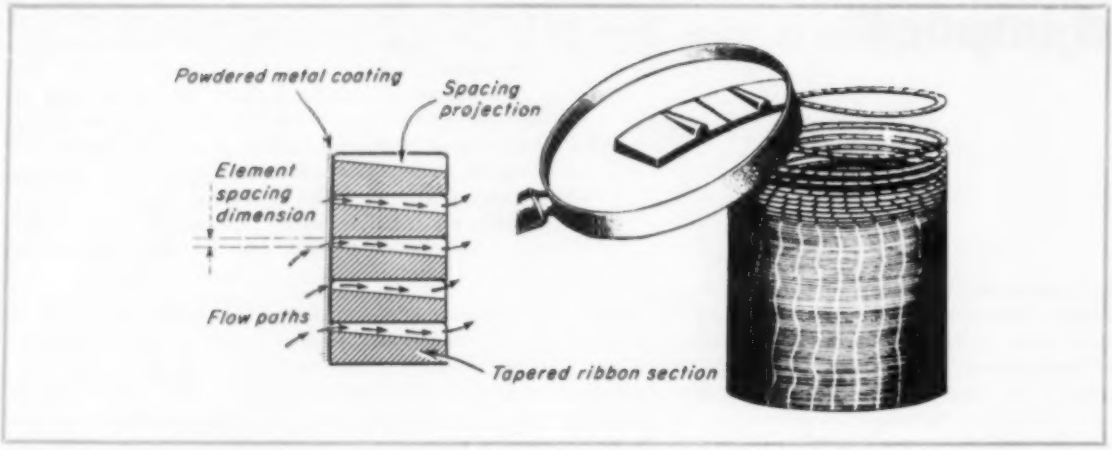


FIG. 4. SEPARATE SNUBBERS reduce impact at the end of a cylinder's stroke. Differential piston area extends the snubber after each cylinder stroke.



METAL EDGE FILTER ELEMENTS are wound into cylindrical form from ribbon wire having evenly spaced risers or projections. The ribbon has a trapezoidal cross section, and is made from all common metals. For greater strength or finer filtration a powered metal coating may be applied to the outside surface of the element.

Porous metal for filters

• By **H. C. MOUWEN**, *Director, Research & Development, Purolator Products, Inc., Rahway, N. J.*

POROUS metal media is usually associated with sintered metal *powder*. Actually there are three distinct types—coated metal edge, fiber metallurgy, and powder metallurgy.

The metal edge filter patented by Purolator consists of a spiral of specially formed wire ribbon with a trapezoidal cross section. The ribbon is coiled upon coil to form a cylindrical filter element. Wedge-shaped risers on the ribbon separate and accurately space one coil from the next. This produces a tapered slot space between the coils. The slots will not choke up because wedging of solids cannot take place within the filter. Solids remain on its outside surface. Spacing between the ribbon wires, which determines the degree of filtration, can be accurately controlled from 0.001 in. to over 0.020 in.

A new type of metal edge filter is of frameless construction in which the risers are resistance, projection welded to the smooth face of the adjacent coil, giving the element strength and rigidity without a frame. Where increased mechanical strength or finer filtration is required, a porous metal coating or facing can be applied to either or both faces of frameless metal elements. Or the porous media can go all the way through.

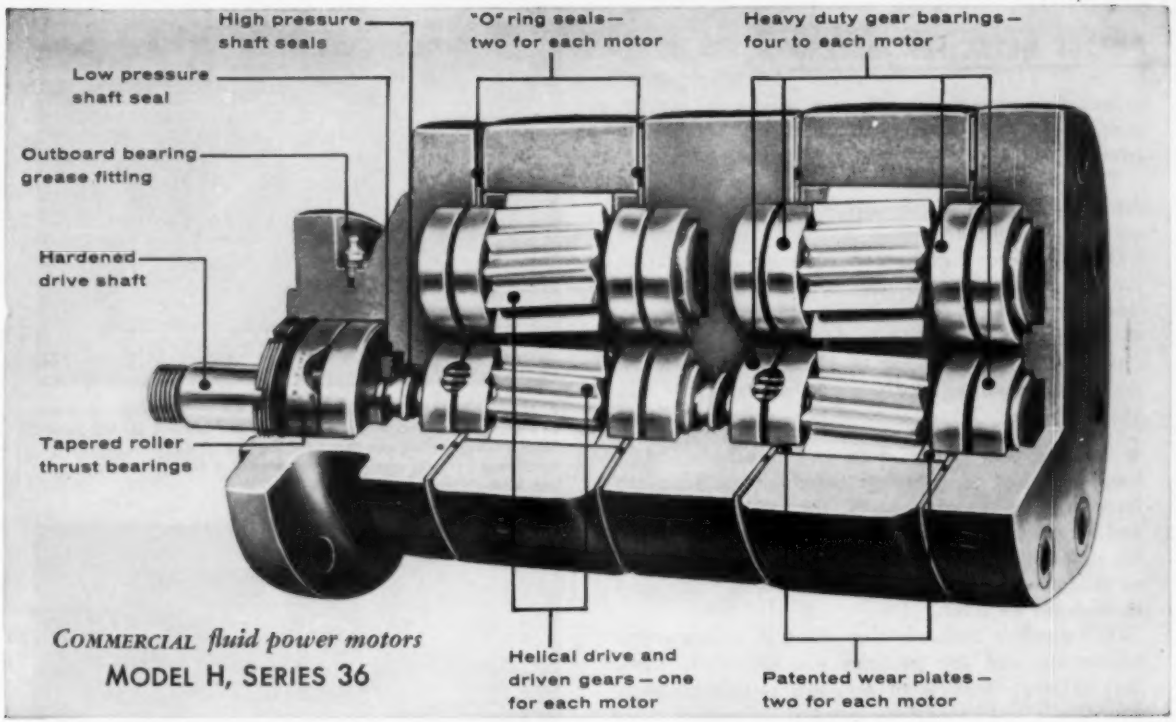
More critical filtration specifications require a porous media with a powdered or fibrous metallurgical base. The fiber base is preferred for flat sheet or disc-shaped porous metal media, while filter elements with convoluted cross sections are more easily designed with a powder-based metal. Fibrous media is specified for filtering between 12 to 60 microns, and powdered metal media will filter effectively to less than 1 micron.

• **Rating Filters**—Usually two characteristics determine the degree of filtration for a porous media. These are:

- Absolute rating which indicates maximum pore opening. No particle larger than this pore opening will pass through the media.
- Average pore size rating which indicates some average pore diameter meeting specific particle removal requirements.

Average pore size requires a word of explanation. Ordinarily, one thinks of adding and dividing numbers to obtain an average. In filtration work, requirements are usually specified at 95 to 100% removal of a given particle size distribution. In most cases 50% retention is of very little value, unless specifically re-

Continued on page 88


High pressure shaft seals
Low pressure shaft seal
Outboard bearing grease fitting
Hardened drive shaft
Tapered roller thrust bearings
"O" ring seals—two for each motor
Heavy duty gear bearings—four to each motor
Helical drive and driven gears—one for each motor
Patented wear plates—two for each motor
COMMERCIAL fluid power motors
MODEL H, SERIES 36

How to get multiple "speed-torque" output

Multiple-speed drive simplified

Efficient operation of heavy mobile equipment frequently involves multiple speeds. Not so efficient, however, is the shifting of gears, the power take-offs, clutches and gear transmissions involved in gaining these desired speed levels with mechanical drives—not to mention the constant maintenance headaches these same drives entail.

Pictured above is one Commercial fluid power oil-hydraulic motor that now delivers low and high speeds efficiently—completely eliminates the problems mechanical drives ordinarily involve.

Two motors work in tandem

This Commercial Model "H" tandem motor actually involves two single motors of equal output mounted on one common drive shaft. When fluid power from the pump source is directed by simple valving into just one of the single motors, the shaft rotates at the high speed. The other single motor on the same shaft receives no input and therefore merely turns. When low speed is required, the total fluid power delivery from the pump is valved into both of the single motors. And of course motor torque at this reduced speed is doubled. This simplified control of two speeds—both low and high—is possible in either direction, forward or backward.

Each of the single motors in this Model "H" tandem motor has one-inch gears. With a fluid power input of about 15 gpm at 1200 psi, for example, when one of the single motors receives the entire input, rotation is 1200 rpm. When the same input is split between the two equal size single motors, rotation is 600 rpm.

Model "H" motors are available with gears in widths of 1", 1¼", 1½", 2", 2½" and 3". Any combination of gear sizes is practical.

More than two speeds

Even three speed operation can be obtained with Commercial double tandem motors when gears of different widths are used in each single motor. High speed operation results when the full pump delivery is valved to the motor with the smaller gears, intermediate speed when it is all directed to the larger gear motor, and slow speed when valved to both motors. Commercial Model "H" motors are recommended for continuous duty operation at pressures up to 2000 psi and speeds up to 1800 rpm.

Engineering help available

Be sure to send for your copy of Commercial's "Oil-Hydraulic Motors Catalog H-4". Further information on Commercial's complete line of other fluid power components—valves, pumps and cylinders—is also yours for the asking, as is help and assistance from COMMERCIAL's technical service department.

Address inquiries to Commercial Shearing & Stamping Company, Dept. A-45, Youngstown 1, Ohio.

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quired. Consequently, the average point—the average pore size rating—is the one which gives the high retention.

Two example will show how pore size ratings are determined. For test purposes, spherical glass beads are used to find both ratings. Suppose a filter is tested with glass beads having a particle size distribution ranging from 10 to 30 microns. If no bead larger than 25 microns is found downstream from the filter, the media has an absolute rating of 25 microns. By retaining 95% by weight of glass beads 10 to 30 microns, the porous media has an average pore size of 10 microns.

• **Testing For Pore Size**—As mentioned, glass beads are used to determine these ratings. They are introduced in known quantity, size, and distribution, and flowed through the porous metal specimen. The filtrate then passes through an absolute media, such as Millipore paper, to retain all the beads which pass through the test filter.

The absolute media is then scanned with a photo microscope and the particles are identified, sized, and counted. Needless to say, this is tedious work. Purolator's Test Laboratory searched for another method which could be correlated with the experimental data. Subsequently, the bubble pressure test as described in a report by Lord and Taylor for textile fabrics was adopted.*

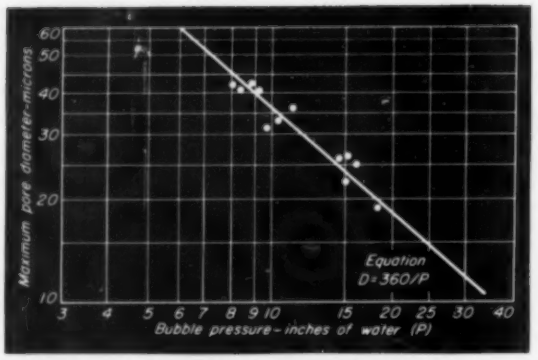
Porous metal filters are available for temperatures from −420 F to 1200 F; pressures from nearly perfect vacuum to 10,000 psi; and filtration from submicronic (smaller than 1 micron) to over 500 microns. Materials have included stainless steel, nickel, Monel, silver, gold, Hastelloy C, aluminum and Durimet 20.

• **Bubble Pressure Test**—For this test you determine the gas pressure necessary to force out of the filter pores, a liquid which wets the filter completely. This pressure, called the bubble pressure, depends on the shape of the filter hole, its size, and the surface tension of the liquid, according to:

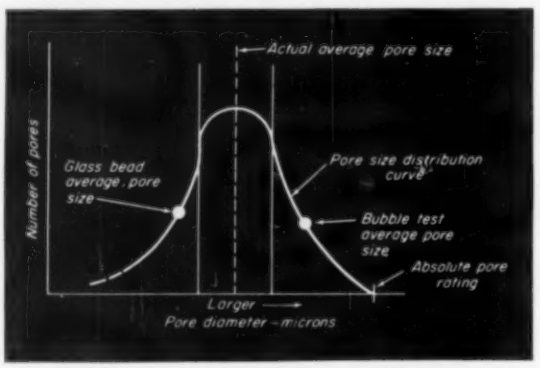
$$R = KS/P \qquad (1)$$

Where: R = the radius of the pore.
S = the surface tension of the liquid.
P = the pressure necessary to blow bubbles through a test section of the porous metal.
K = a constant whose valve depends on the units used to measure S and P.

*J. Lord, and H. M. Taylor, J. Textile Institute, Vol. 45, No. 5, May (1945).



CORRELATION IS GOOD when the results of bubble pressure and glass bead tests for several filters are plotted on log paper. Since the points fall closely about the line of equation D=360/P, we may use it with confidence to predict a filter's maximum pore size from its first bubble point.



A TYPICAL PORE SIZE DISTRIBUTION CURVE for a filter. The average pore size from the bubble point test falls in a region slightly left of the peak, which is the most frequently occuring actual pore size. The glass bead test gives a value slightly right of the peak. Since both values fall consistantly into the same areas, the average from the bubble pressure test is a guide to the actual average pore size.

For this test to be effective, the liquid must wet the porous media completely. If it does not, the equations must be corrected to take this into account.

For the purpose of this article Solox 190, denatured alcohol, was used as the liquid, and the equation reduces to

$$D \text{ (microns)} = 360/P \text{ (inches of water)} \qquad (2)$$

• **A Typical Test**—The porous metal sample is maintained just below the surface of the Solox so that hydrostatic head effects are negligible. To start a test, gas is admitted to the sample. Pressure is increased until the first bubble appears on the surface of the media. This first bubble pressure is recorded, and then pressure is increased until the second bubble appears, and so on. Round filter elements are continuously rotated so that the entire surface is scanned. Depending on the pore distribution, a pressure is reached where the entire porous surface "boils", and individual bubble sites are almost lost. This is called the boil point. A record of a typical bubble test is given in the table.

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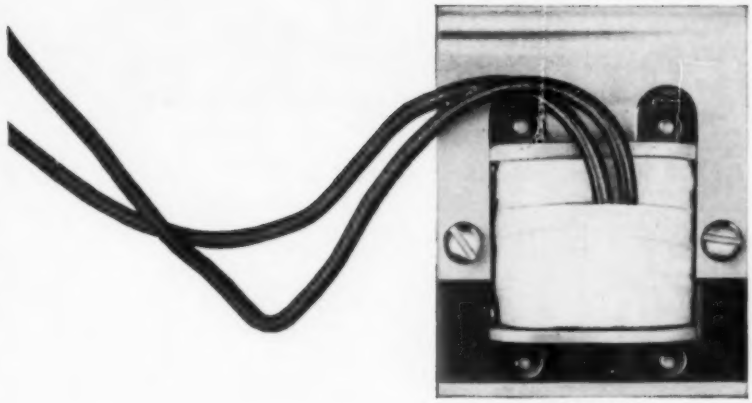
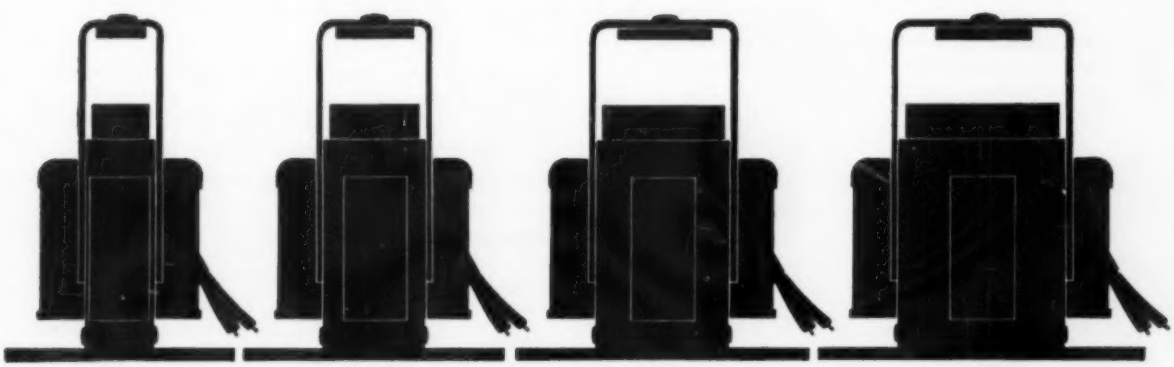


actual size

Single Purpose Solenoid ... National Acme's "T" New T Type



T-APR T-BPR T-CPR T-DPR

(Silhouettes . . . 85% actual size. Push range up to eight pounds at ½" stroke.)

National Acme's new "T" Type solenoid is designed specifically and solely for hydraulic and pneumatic valve applications . . . proved by months of exhaustive testing by leading valve manufacturers. As you can see, there are four sizes offering a push range of two to eight pounds with up to a half inch stroke. The "T" Type is available with push pins of various lengths and diameters (captive or loose), and either a standard bobbin or epoxy molded coil. Get full details. Check with any of our nationwide staff of sales engineers, or, get in touch with us here in Cleveland. We'll look forward to hearing from you.

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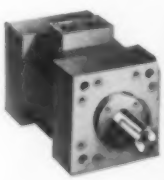
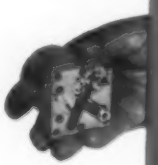


MODEL RN—Roller bearing model for high pressures, fast cycles. Sizes from 4¼" x 4¼".

MODEL HN—Uses journal bearings for moderate pressures and cycles. Units as small as 4¾"x4½".



NEW MIDGET MODEL—Measures 2" x 2" x 2", weighs only 12 ounces. Torque ratings to 80 in. lb. Ideal for instruments and other light applications.

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POROUS METAL FOR FILTERS

Typical Bubble Pressure Test Data

BUBBLE NO.	PRESSURE (in. water)
1	6.8
2	8.6
3	8.9
4	8.9
5	8.9
6	9.8
7	9.8
8	9.8
9	10.8
10	10.8
Boil	15.6

Absolute Rating

$$D = \frac{360}{6.8} = 53 \text{ microns}$$

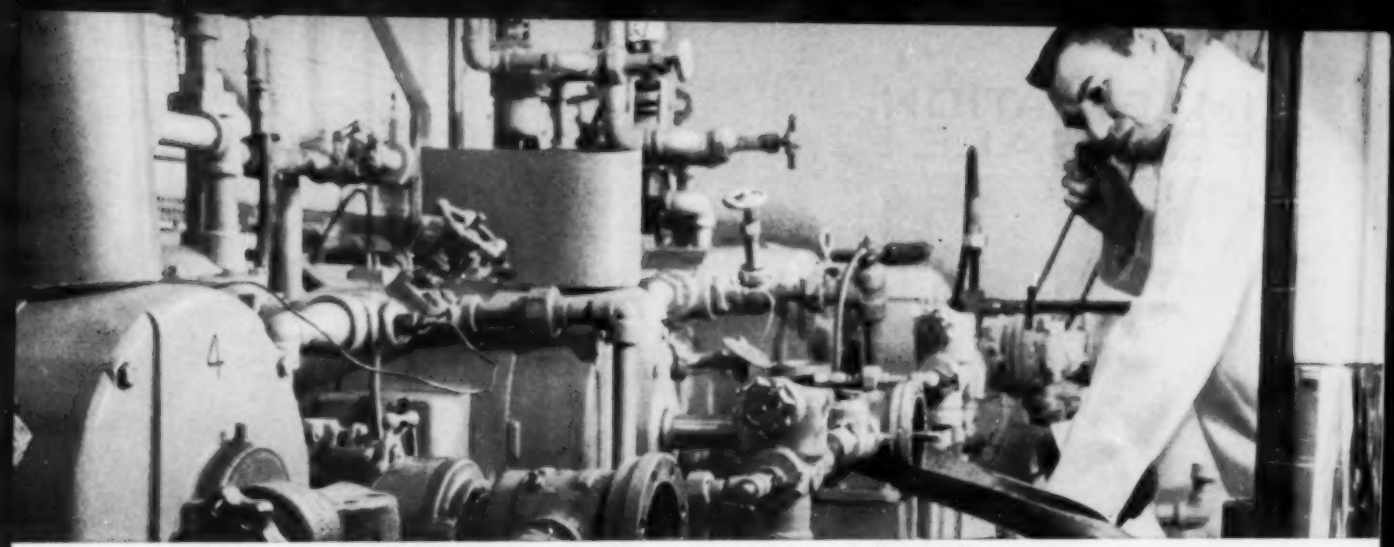
Average Pore Size

$$D = \frac{360}{15.6} = 23.1 \text{ microns}$$

• **Correlate Glass Bead Count With Bubble Test**—Maximum pore diameter (absolute rating) determined by a particle size analysis of the glass bead test of a filter can be correlated with maximum pore diameter resulting from the bubble pressure test. We have plotted on log log paper the first bubble pressure P (it could have been converted into D) and maximum pore size from the glass bead test for each of several porous metal filters. Next, we draw the line of equation $D=360/P$ (equation 2). Since correlation is good about the line, we may calculate the maximum pore size of a filter with a fair accuracy by using the bubble pressure test. The more carefully we inspect the downstream glass beads, the closer is the correlation.

• **Average Pore Size**—If we physically measure and count the pores in a filter (by sampling), we can plot a pore size distribution curve. The average pore size is the one with the greatest frequency in a specific region. In correlating the average pore size from the glass bead and bubble pressure tests for a filter, we find that the two test results rarely coincide, and also that neither one coincides with the actual average.

Filter and test characteristics explain the non-correlation. Because of the tortuous paths through the filter, a glass bead probably will not pass through a pore of its exact size (diameter). It will be stopped. This makes the porous media appear tighter and have a finer pore size than it really has. And the glass bead test gives an average value just to the left of the peak. The bubble test indicates pore sizes according to the bubbles emanating from the surface of the porous media. Under the surface the pores may be restricted and tortuous. This makes the porous media appear more open and have a coarser pore size than it really has. And the bubble pressure test gives an average value just to the right of the peak. To date, a method has not been developed that will put these values in the center of the distribution peak. Despite this poor correlation, both values fall consistantly into the same regions. Thus, calculated average pore size ratings from bubble tests can be used as a guide to real values. ▼▼▼



Listening for pump chatter. Here—in Shell's Martinez, California, laboratory Shell Tellus hydraulic oils are subjected to the most demanding tests.

BULLETIN:

Shell presents a question-answer guide to help you select the hydraulic oils for top performance

Selecting the proper hydraulic fluid for your equipment can be one of your most important decisions. And it can pay off in many ways. Less down-time. Longer equipment life. Lower cost per unit.

Here are six bench marks to help you pick the best hydraulic oil for your plant requirements.

1. Does it have good oxidation stability? Oxidized hydraulic oil can form gums, lacquers and other deposits which may foul moving parts. Shell Tellus Oils are carefully refined to remove unstable, sludge-forming components—then fortified with a Shell-developed oxidation inhibitor.

2. Will it resist foaming and emulsification? Pump chatter and erratic operation are often the result of pump cavitation, brought on by oil foaming. Tellus® Oils contain additives to help prevent foaming.

3. Does it fight rust and corrosion? It is difficult to exclude all moisture from a hydraulic system. And moisture can form troublesome rust. Shell Tellus Oils have been carefully compounded to resist corrosion.

4. What are its lubrication qualities in continuous service? Shell Tellus Oils form a clinging, oily film on mating metal surfaces. This maintains a constant guard against wear.

5. How does it react to temperature changes? This is a key factor in the performance of hydraulic equipment. Careful selection of the proper viscosity grade of Tellus assures satisfactory operation of your system over its entire temperature range.

6. Is it available in several viscosity grades? Shell Tellus Oils are available in a broad range of viscosity grades. There's a special grade for virtually every hydraulic requirement.

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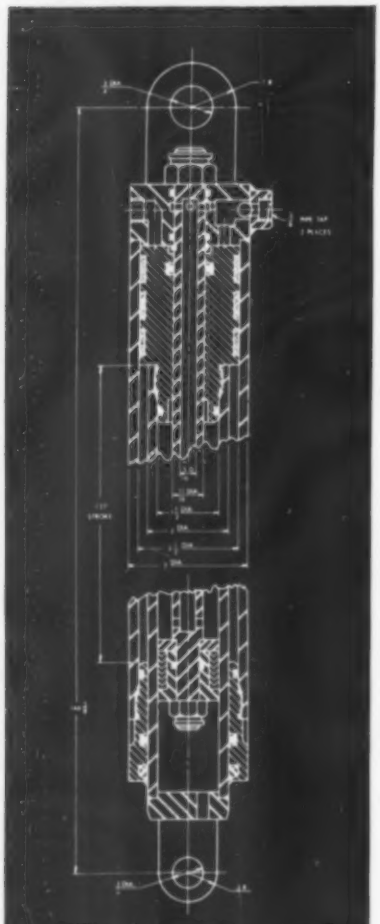

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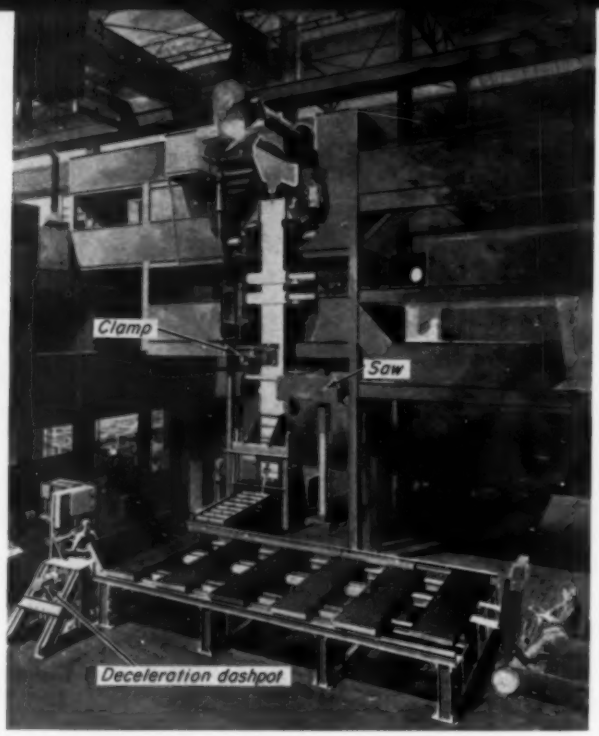


FLAT METAL CONTINUOUS CASTING machine produces brass bars. Brass is poured into top of machine, cooled, and then cut to length by hydraulically actuated saw.

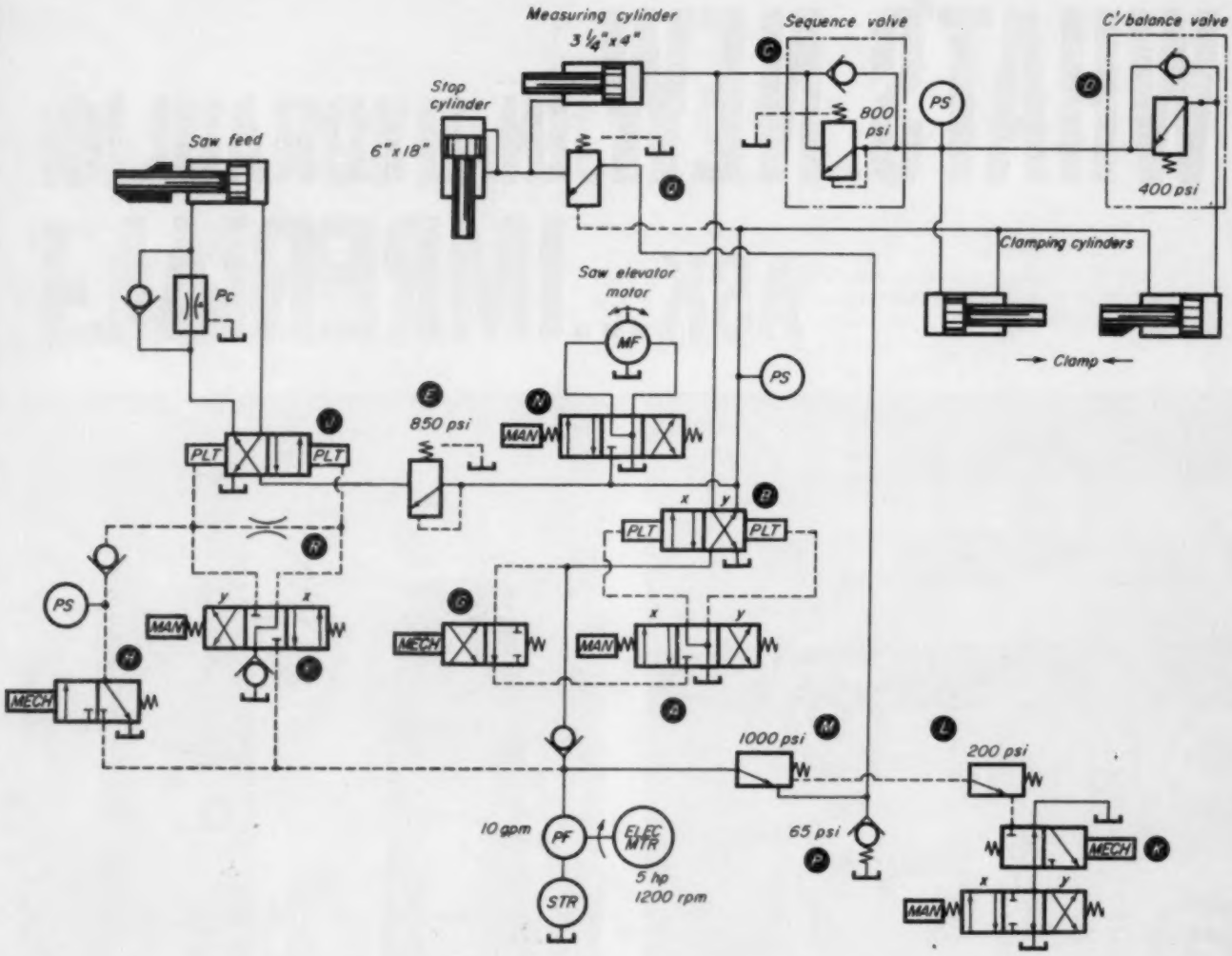
Cams make billet cutter operation safe

• By **ALLAN M. STEEL,** *Hydraulic Engineer, Scovill Manufacturing Co., Waterbury, Conn.*

SAFETY is the watchword on this hydraulically operated 4-story high machine that continuously casts brass billets, and cuts them to length. Hydraulic pilot lines and control valves are interconnected so that it is impossible to open the clamping cylinders while the saw is feeding into the work. The saw will not operate while a billet is unclamped.

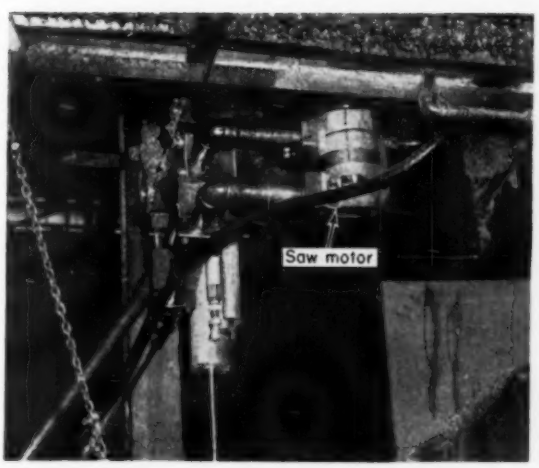
• **Clamping Circuit Has Priority**—When valve *A* is shifted to position *x*, it directs pilot fluid to actuate valve *B*. Oil flows through the counterbalance valve and sequence valve checks to the head ends of the clamping and the measuring cylinders. Oil also flows to saw motor control valve *N*. When pressure has built up in the oil measuring and clamping circuits, sequence valve *E* opens.

• **Cam Cuts Off Pilot Pressure**—The operator shifts valve *F* to its *x* position, actuating valve *J* and extending the saw feed cylinder. The forward cam on the cylinder rod immediately depresses valve *G* which cuts off pilot pressure to valve *A*. Thus, if the control lever of valve *A* is moved nothing happens, because there is no pilot pressure to shift valve *B*. This safety feature insures that the work is never unclamped while the saw is cutting.



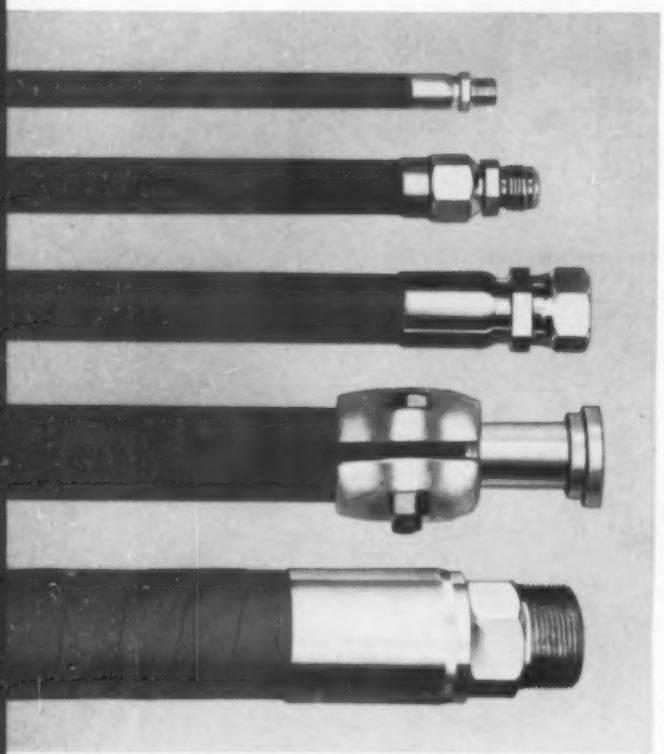
• **Saw Feed Cylinder Reverses Automatically**—At the end of the cut the rear cam on the saw feed cylinder depresses valve *H* which actuates valve *J*, to retract the saw feed cylinder. Note that the lower cam on the saw feed cylinder keeps valve *G* depressed through the entire stroke.

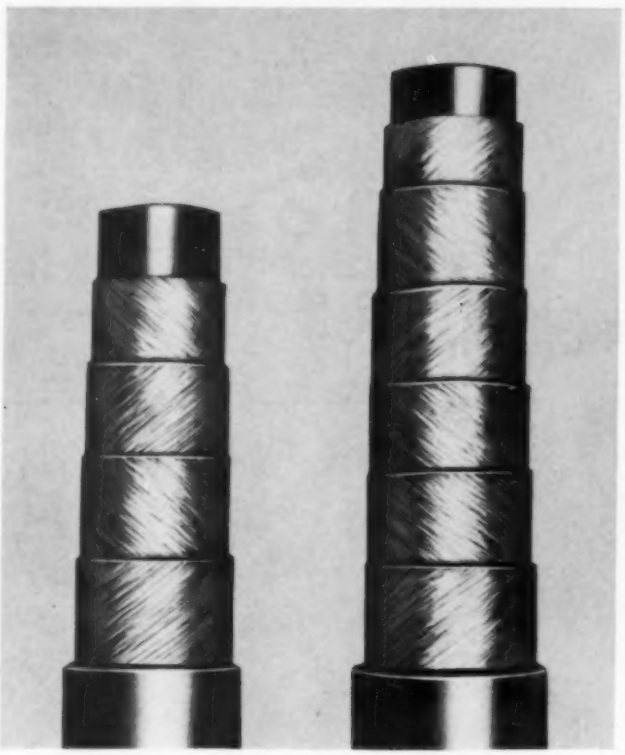
• **System Pressure Drops After Unclamping**—After the saw retracts, the operator moves valve *A* to its *y* position. This shifts valve *B* to its *y* position, cutting off system pressure from the saw motor and retracting the clamp cylinders. This safety design feature insures that the saw does not cut while the work is unclamped. System pressure also feeds a pilot line to sequence valve *Q* which opens. A 65-psi check valve *P*, lets oil flow through sequence valve *Q*, retracting the measuring stop cylinders. These cylinders retract together with the unclamping cylinders. After unclamping, the cam on the right-hand clamping cylinder actuates valve *K* which connects pilot relief valve *L* to tank and lets main relief valve *M* unload the system.



FLUID MOTOR drives cut-off saw. Motor is not affected by process water, chips, and oil that continually fall on it.

WHAT'S NEW IN HYDRAULIC ASK...IMPERIAL-





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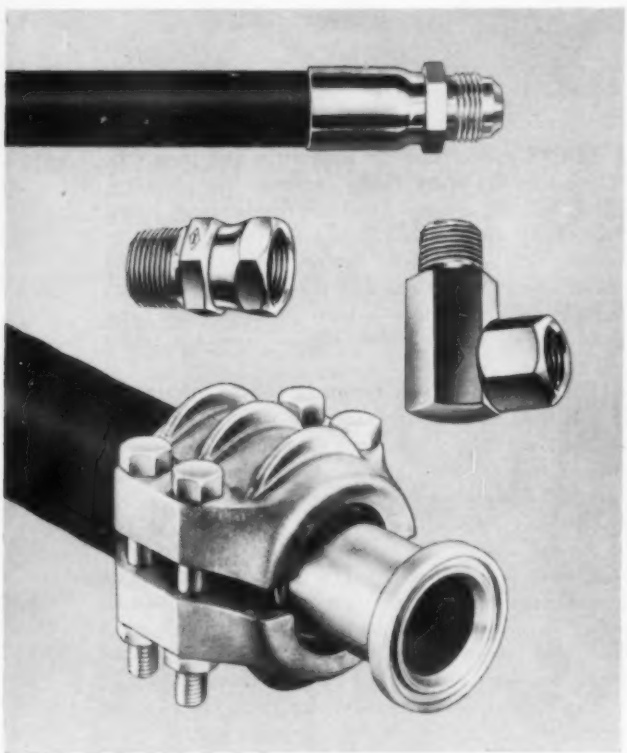

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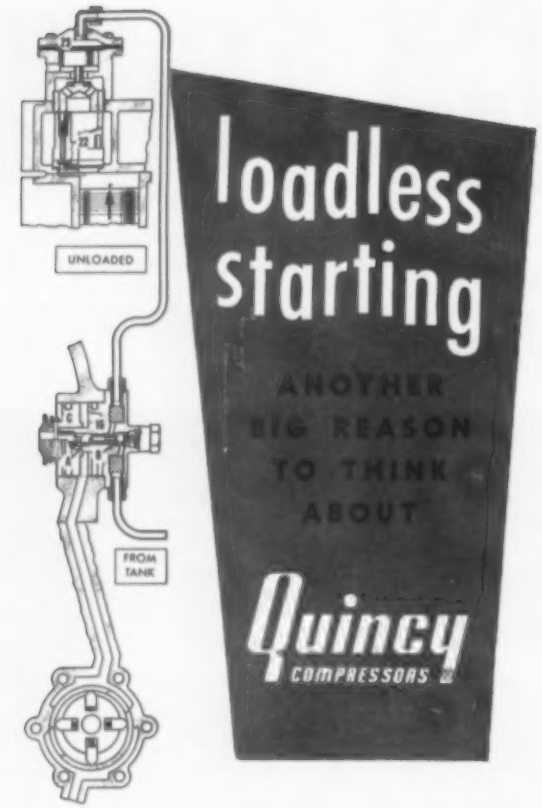

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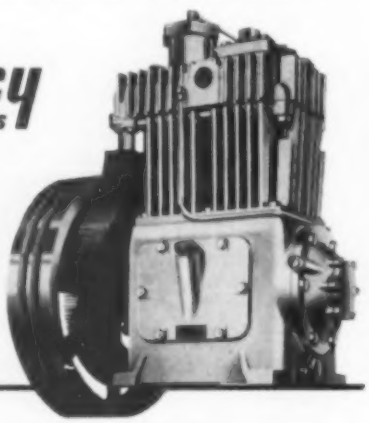

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Signals from transformers control a ship's rudder by directing the servovalve which controls a 2-way pump. Only two pipes connect the pump to the cylinders.

Servo pump controls

A SHIP'S rudder may be accurately and positively positioned hydraulically without flow control valves. Instead, a 2-way, variable displacement pump directed by an electrohydraulic servovalve produces smooth, rate responsive, stepless rudder movement that is shock, vibration, and pulsation free. Linear, variable differential transformers provide initial command signals and feedback signals from the pump and rudder.

• **Differential Transformers Give Signals**—In this steering gear, the most important components are the 2-way pump which can direct its flow to either single-acting cylinder, and the three identical, linear, variable differential transformers. (LVDT's). They are actually coils with a core or slug moved axially in the coil airgap. When the core is in a central position, there is a null signal. The transformer produces a maximum signal at the maximum limits of travel, either in or out. The pump feedback, rudder feedback, and command LVDT's emit signals proportional to the positions of the units they are attached to.

The command and rudder feedback LVDT's are electrically connected so their voltages are of opposite phase. The resultant voltage goes to the input of the transistor amplifier where it is amplified and applied to the torque motor of the servovalve. When the rudder is in the correct position as commanded by the wheel, the two LVDT voltages are equal, so the voltage at the amplifier input is zero.

With zero input voltage, the amplifier output voltage is also zero, and no force is exerted by the torque motor. The spool in the servo is spring-centered and closed, holding the pump slide block at neutral. The pump at zero flow in turn holds the rudder cylinders in position.

• **Servovalve Moves Pump Slide Block**—Turning the pilot wheel to move the rudder to a new position, produces a voltage in the command LVDT greater or smaller than the rudder feedback voltage. The resultant amplified voltage causes the torque motor to deflect according to the phase of the voltage and moves the servovalve spool in that direction. The servovalve ports oil to or from the slide block cylin-

ship steering

Courtesy of The Oilgear Company.

PUMP-RESERVOIR-CONTROL ASSEMBLY. Two-way, variable displacement pump has a electrohydraulic servovalve control for its slide block. Components are manifolded to the assembly. This reduces the amount of piping and allows the assembly to be installed in one unit.

der to move the pump on stroke in the required direction and volume. The pump delivers oil to the proper rudder cylinder to move the rudder. Movement continues until the rudder LVDT again has a voltage identical to the wheel LVDT voltage. When the LVDT voltages are equal, the servovalve is again centered and the pump is at neutral. This completes the cycle.

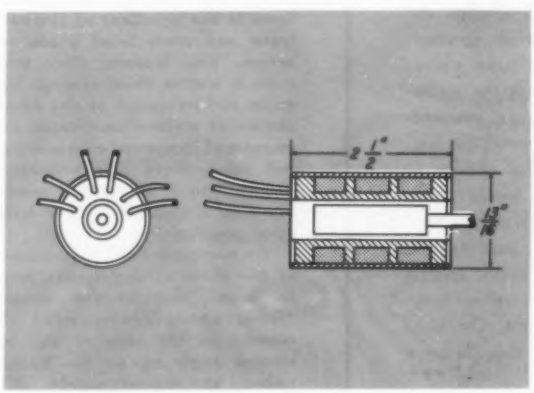
• **Pump Has Feedback Also**—During the cycle, the pump feedback LVDT has also been sending its signal to the amplifier for comparison. It measures the position of the pump slide block and therefore the pump's flow. This insures that pump output is always under error signal control. This signal is required so that the system is stable. If this feedback is removed, the system will oscillate continuously because there are then two time integrations, one of slide block position and one of rudder position.

The speed with which the system responds depends on the voltage gain of the transistor amplifier. With high gain the servovalve is opened wide with only a small error voltage. Gain for both the pump slide block signal and rudder LVDT signal are adjustable at the amplifier. These gain adjustments should be set as high as possible for fastest response and

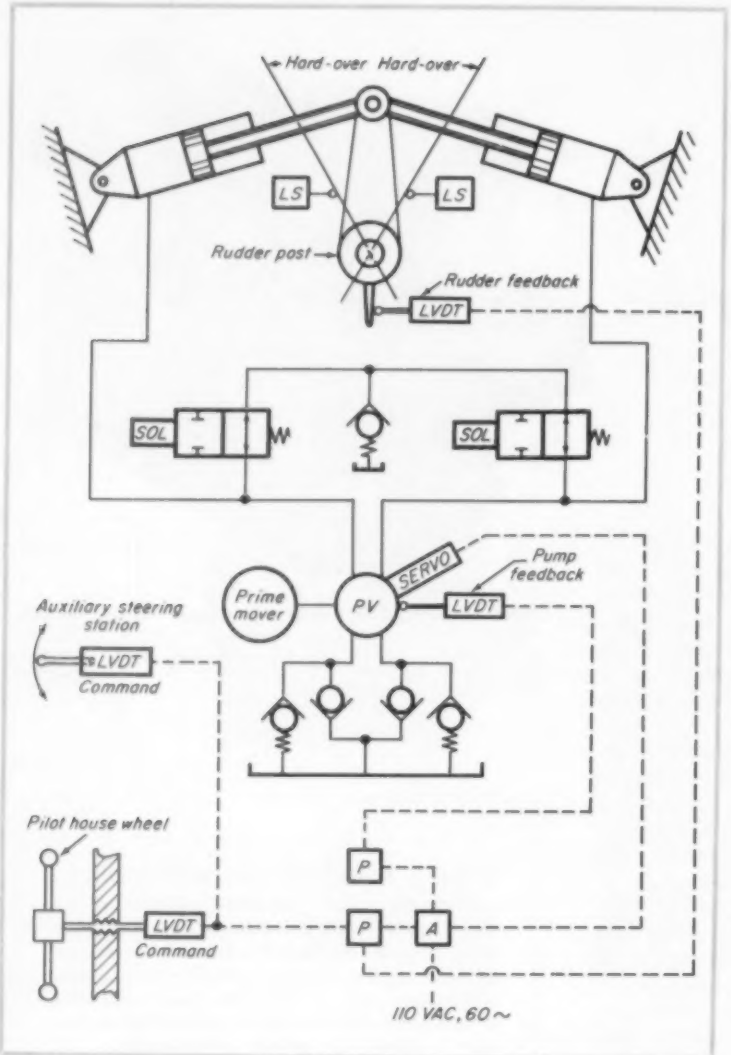
STEERING GEAR DESIGNER'S RESPONSIBILITY

Accurately and positively positioning a ship's rudder while going ahead or astern with rated response to signal commands states the problem for power steering. Rudder forms, like ship's lines, are individually conceived. This means each steering gear application represents a somewhat unique accommodation.

When confronted with an actual, scaled rudder outline, designed speed ahead and astern, angular limits of rudder movement, and a hard-over to hard-over time limit, the steering gear designer has the responsibility for correctly gaging and containing the forces involved. He undertakes to supply a steering gear that is guaranteed to steer the ship as specified, and at the same time satisfy the rules, regulations, and material specifications governing marine usage and inspection. His design is proved at the ship's trial run.



LINEAR, VARIABLE DIFFERENTIAL TRANSFORMER PRODUCES a voltage proportional to the length of the slug's axial movement through the center of the coil. Also the voltage is proportional to the speed of slug movement. The signals from the command and feedback LVDT's are compared in the transistor amplifier.



STEERING GEAR CIRCUIT has two 4-in. bore x 22-in. stroke, clevis-mounted, single-acting hydraulic rams. Precise rudder movement results from comparing command and feedback signals and applying the resultant to the servovalve of the 2-way pump. The number and style of auxiliary steering stations is optional.

desired accuracy. However, if either gain is set too high the system will oscillate.

• **Voltage is Proportional to Movement**—Rapid motion of the pilot wheel generates a larger signal in the command LVDT (more lines of flux are cut per second), resulting in full servovalve spool movement and, therefore, rapid rudder turning. Similarly, slower wheel movement results in slower rudder movement.

• **Limit Switches Not Required Now**—On this early application limit switches were required. A limit switch at each extreme of rudder motion de-energizes a solenoid by-pass valve. This bypasses oil from the cylinder back to the reservoir, preventing rudder motion beyond the limit switch position. The rudder is immediately free to move away from the switch when pump flow reverses. The U.S. Coast Guard recognized that the limit switch and solenoid by-pass valve combination was redundant. On subsequent applications this feature was not required. ▼▼▼

Three basic arrangements can be used.

First, there is the *tiller quadrant* in which a drum segment equal to the required arc of traverse is substituted for the tiller arm, with a suitable arrangement of sheaves and cable. The cable ends are attached to a double-ended rod, double-acting, fixed ram. The other ends of the cable are symmetrically attached to the drum segments. The motion of translation of the ram is literally belted to the tiller quadrant. The effective torque arm is the radial distance at the tiller quadrant. The ram stroke coincides with the arc length traversed.

Second, there is the *clevis* in which opposed rams are pin connected to a tiller arm with either single-acting or double-acting cylinders, pin secured at their fixed ends. The ram stroke required corresponds to the cord length of the arc of traverse traced by the tiller arm. The fixed, cylinder clevis pins will also lie on the projected centerline of the chord. Thus, the effective torque arm is the perpendicular distance from the ram centerline to the rudder stock. Torque is least at the arc traverse ends.

Third, there is the *Rapson slide* in which the tiller arm is slotted for a sliding, crosshead guided, thrust pin. The thrust pin is carried at the junction of fixed opposed rams. Since the only effective force, neglecting friction, on the tiller arm is normal to the slot, the effective torque arm increases as the secant of the angular displacement from center. The effective force is the resultant of the ram force and cross head guide reaction. The Rapson slide provides a higher than average angular rudder speed at the small angles of rudder movement encountered in normal course-keeping. Also, there is a reduction in the speed of rudder movement as it approaches the hard over position.

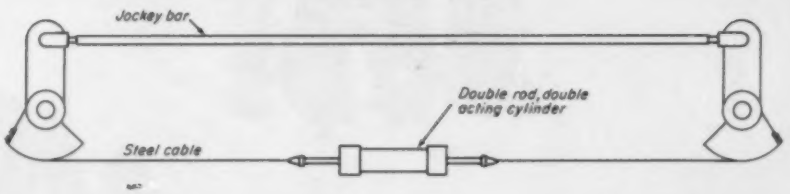
To compare the performance of the three arrangements, bear in mind that rudder torque (from water resistance) increases as the sine of the included angle up to the burble point, at approximately 35°,

linkages using hydraulic rams

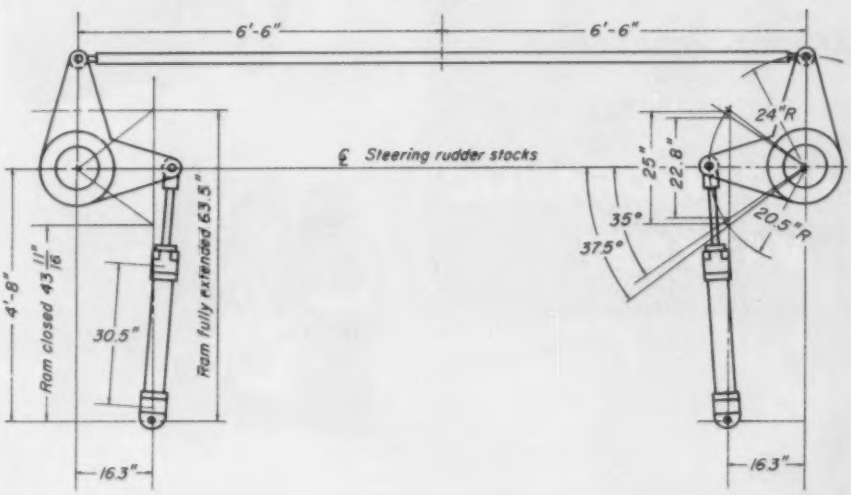
where flow becomes turbulent. For comparison of their torque-producing capability at 35°, assume that the three arrangements have rams that produce equal thrust. Then the ram stroke length ratios will be 1.00 for the Rapson slide, 1.30 for the quadrant arrangement, and 1.49 for the clevis arrangement. Thus, the Rapson slide requires the shortest stroke for a given torque. And, of course, these ratios have direct bearing on the rudder's hard-over to hard-over time that can be accomplished with a given pump displacement and power input.

In the Rapson slide and clevis arrangements, single or double-acting rams may be used. Double-acting rams, with appropriate plumbing and controls allow one ram to push and the other to pull at the same time. This greatly increases the force available for rudder turning. For example in the Rapson slide above the rams have an 8 in. ID and a rod diameter of 5⅝ in. Assume 1350 psi in both rams. The 8 in. ID gives a pushing area of 50.266 sq. in., which produces a pushing force of 67,859 lb. The differential area in the other ram gives a pulling area of 25.416 sq. in., which pulls with 34,312 lb. The total area of 75.682 sq. in. produces 102,171 lb force on the thrust pin. Maximum torque at the center of ram motion is 102,171 lb x 22.5 in ÷ 12 = 192,000 ft-lb.

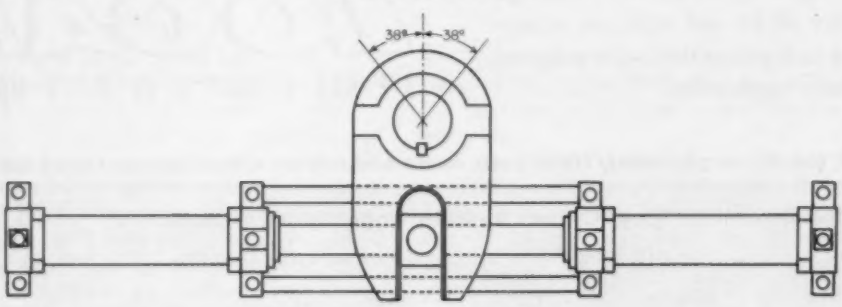
TILLER QUADRANT

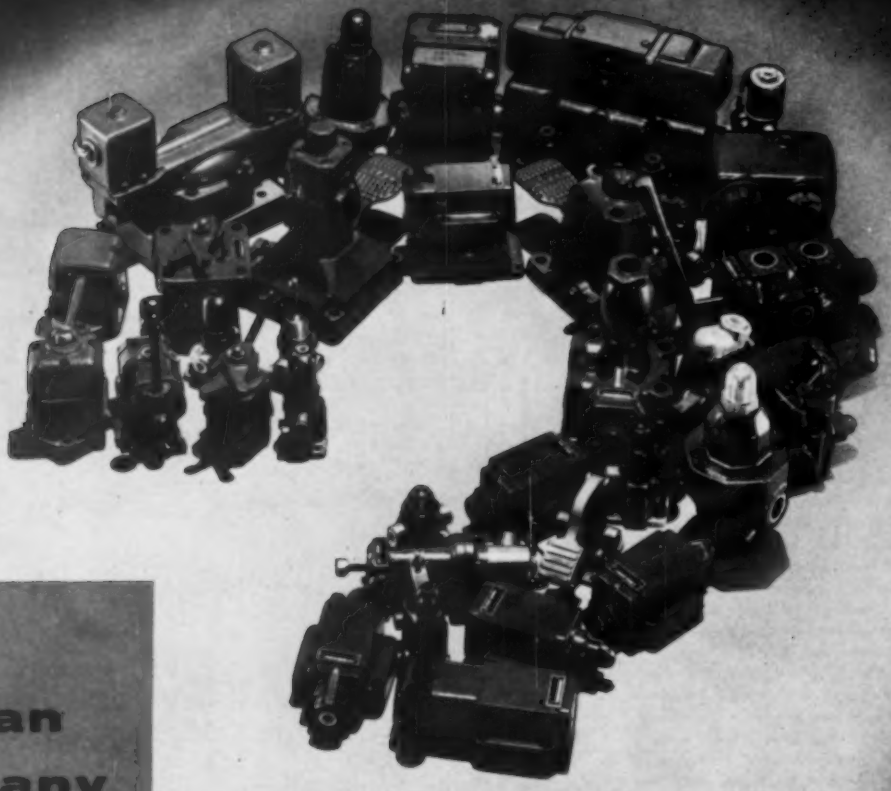


CLEVIS



RAPSON SLIDE





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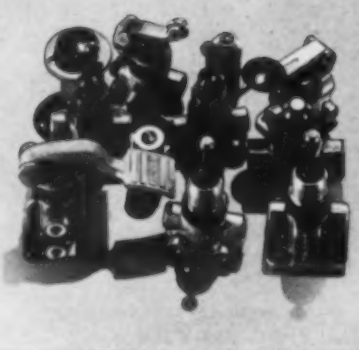

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Pump design by force balance

• By **NISSIM FRANCO**, *Consulting Engineer, Tel-Aviv, Israel*

Best operation of a swashplate pump depends largely on design of the port plate. This article develops mathematical relationships which can minimize trial and error.

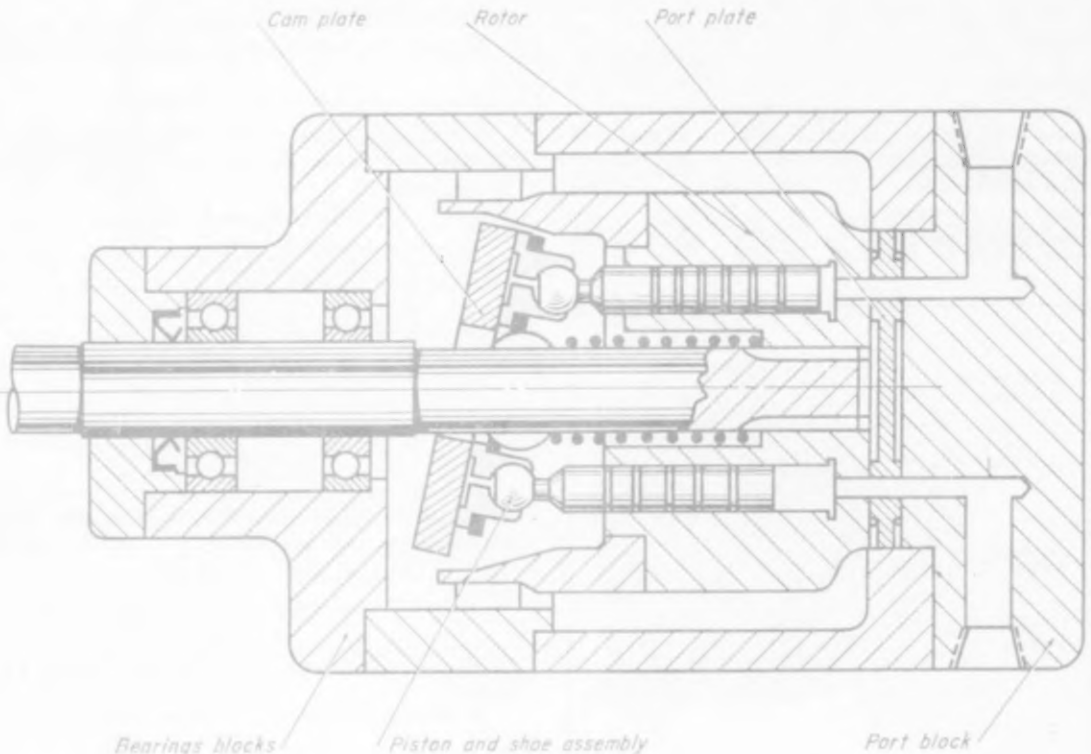

FIG. 1. AXIAL PISTON PUMP with port plate which connects delivery from discharging pistons and also connects fluid to suction pistons.

ONE TYPE of axial piston pump has pistons reciprocating in a rotor which is driven by the pump shaft. The pistons are connected to the cam plate which is at an angle with the axis of rotation, reciprocating the pistons. Suction and discharge are each performed in about half a revolution, and the valve plate ports are semi-annular. For best operation and least leakage the rotor and port plate must fit together perfectly.

Two opposing forces act on the port plate. The pistons forcing the fluid out the discharge port exert a resultant force tending to force the rotor against the port plate. On the other hand, fluid leakage between the port plate and the rotor produces a force due to pressure drop. This force, together with pressure in the discharge port tends to separate the rotor and port plate.

If the piston force is predominant, the rotor is forced against the port plate, resulting in high friction, rapid wear, and overheating. Efficiency will be very low. If, on the other hand, the hydraulic force is predominant, the rotor will separate from the port plate, and discharge fluid will be lost in internal leakage. Volumetric efficiency would be low, and again the fluid would overheat.

The ideal is for these two forces to be equal. Then a negligible leakage lubricates the bearing surface and insures a quiet and steady operation at high pressures.

To find the relation between the forces, the problem can be divided into three steps:

a) Find pressure distribution on the portplate.

b) Find resultant force of this pressure.

c) Find resultant force of the piston action.

• **Pressure Distribution on the Port Plate**—Because clearance between the rotor and port plate must be small, and because leakage through it has to be a small predetermined quantity defined by the required volumetric efficiency, we can assume that fluid flow in the clearance is laminar. Pressure distribution on the outer land is different from the inner land, and we shall compute them separately.

To compute pressure distribution on the outer land, consider a differential fluid element in motion in this clearance. (Figure 2).

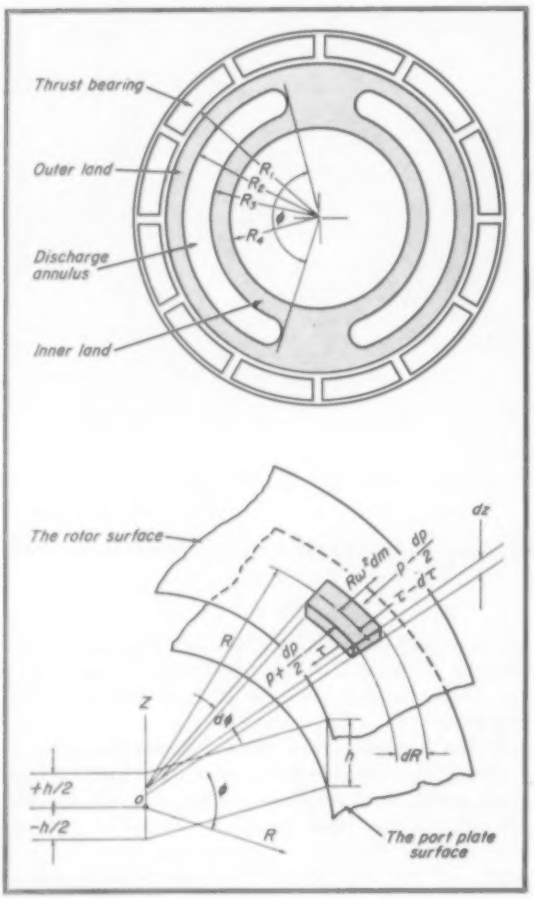

FIG. 2. FORCES acting on differential fluid element in outer (R_1 — R_2) land of port plate.

This element is confined by two radial sections forming an elementary angle, $d\phi$, and two concentric arcs with radii R and $R+dR$. If the total height of the slit is called h, the thickness of this fluid element will be called dz. These dimensions use a semi-polar-coordinate system, R, ϕ, Z.

The area of the elementary, inner cylindrical surface is $(R-dR/2)\,d\phi dz$ and $(R+dR/2)\,d\phi dz$ is the area of the outer cylindrical surface.

Several elementary forces act on the fluid element. On the inner, cylindrical wall fluid pressure is forcing it to the outside. The resulting force is,

$$(p + dp/2)\ (R - dR/2)\ d\phi\ dz$$

where: p = pressure at radius R

Similarly the force on the outer cylindrical surface is

$$(p - dp/2)\ (R + dR/2)\ d\phi\ dz$$

A centrifugal force produced by rotary motion of the fluid also acts on the particle. This force is given by the formula

$$C = mR\omega^2$$

where: m = Mass of the body
R = Radius of gyration
ω = Angular velocity

In our case the differential mass is

$$dm = \rho\, dV = \rho R\, dR\, d\phi\, dz$$

where: ρ = Specific gravity of the fluid.

Therefore, the centrifugal force is

$$C = \rho R\omega^2\, R\, dR\, d\phi\, dz$$

We must also add those forces produced by viscosity, or tangential stresses in the fluid in motion. These forces are expressed by:

$$(\tau - d\tau)\ R\, dR\, d\phi$$

for the upper surface and

$$\tau R\, dR\, d\phi$$

for the lower surface, where τ = Tangential stress in the lower surface.

Because all these forces must be in equilibrium,

$$(p + dp/2)\ (R - dR/2)\ d\phi\ dz + \rho R\omega^2 R\ dR\, d\phi\, dz + (\tau - d\tau)\ R\, dR\, d\phi = (p - dp/2)\ (R + dR/2)\ d\phi\, dz + \tau R\, dR\, d\phi$$

Simplifying and neglecting infinitestimal values of higher degrees:

$$Rdpdz - pdR\, dz + \rho R^2\omega^2\, dR\, dz = R\, dR\, d\tau \quad \ldots\ldots\ldots\ldots (1)$$

This basic equation gives, in a differential form, pressure distribution in the outer land of the port plate.

The Newton viscosity law gives:

$$\tau = \mu \frac{dv}{dz}$$

where: τ = Tangential stress
μ = Coefficient of dynamic viscosity
$\frac{dv}{dz}$ = Velocity gradient between parallel walls of the elementary particle.

Consequently

$$d\tau = \mu \frac{d}{dz}\,(dv/dz)\, dz$$

Substituting this in equation (1),

$$Rdp - pdR + \rho R^3\omega^2\, dR = \mu R\, dR \frac{d}{dz}(dv/dz)$$

Two simple integrations of this differential equation give, when taking into consideration the limit conditions:

$$Z = 0, \frac{dv}{dz} = 0 \quad \text{and } z = h/2, v = 0$$

These show that velocity is maximum at the middle of the clearance and zero at the walls.

Velocity distribution in the clearance is,

$$v = \frac{1}{2\mu}(dp/dR - p/R + \rho\omega^2 R)\ (z^2 - h^2/4) \quad \ldots\ldots\ldots (2)$$

This distribution follows a parabolic law.

We can now compute leakage flow q,

$$q = 2\int_0^{h/2} v\, ds$$

where: $ds = \phi R\, dz$

After integration,

$$q = (-\phi/R12\mu)\ (dp/dR - p/R + \rho\omega^2 R)\ h^3 \quad \ldots\ldots\ldots (3)$$

Here, ϕ is the total angle of the discharge port.

The minus sign for q denotes that crescent pressure and leakage flow are in opposite directions.

We can now express the pressure distribution as a linear differential equation:

$$Rdp/dR - p + \rho\omega^2 R^2 = -12\mu\, q/\phi\, h^3$$

Integrating:

$$p = R(C + 12\mu\, q/\phi\, h^3 R - \rho\omega^2 R)$$

Since pressure in the outer side of the land is practically zero:

$$p = (12\mu\, q/\phi\, h^3)\ (1 - R/R_1) + \rho\omega^2 R\ (R_1 - R) \quad \ldots\ldots (4)$$

Here R is the radius between R_1 and R_2

Since pressure at radius R_2 is constant and equals discharge pressure p_0,

$$h^3 = \frac{12\mu\, q\ (1 - R_2/R_1)}{\phi[p_0 - \rho\omega^2 R_2\ (R_1 - R_2)]} \quad \ldots\ldots\ldots (5)$$

Also

$$p = \rho\omega^2\ (R_1 - R)\ (R - R_2) +$$

$$p_0\ (R_1 - R)/(R_1 - R_2) \quad \ldots\ldots\ldots (6)$$

• **Pressure Distribution on Inner Land**—Referring to Figure 3, consider an elementary fluid volume leaking from the discharge orifice through the clearance between the *inner* land of the port plate and the rotor's face.

The following forces are acting on it:

a) A hydraulic force on its outer cylindrical surface with value:

$$(p + dp/2)\ (R + dR/2)\ d\phi\, dz$$

b) A hydraulic force on its internal cylindrical surface with value:

$$(p - dp/2)\ (R - dR/2)\ d\phi\, dz$$

Both hydraulic forces are produced by pressure drop due to leakage flow. These forces are opposite.

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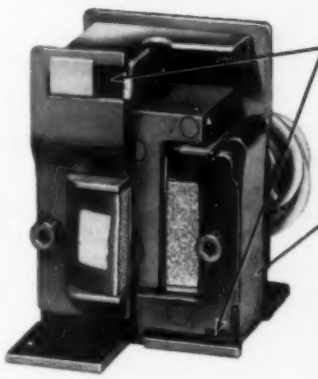

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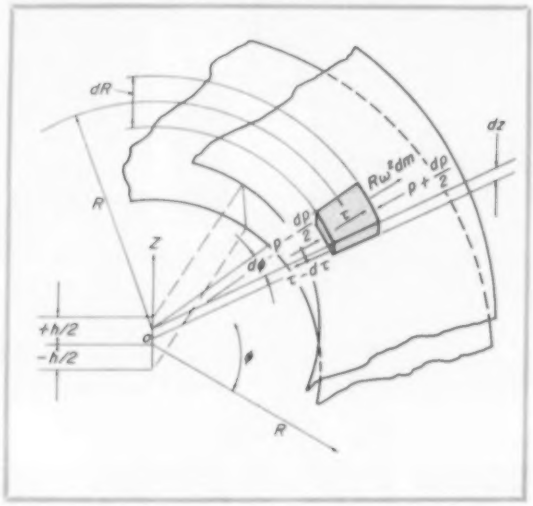

FIG. 3. FORCES acting on differential fluid element of inner ($R_3 - R_4$) land of port plate.

The centrifugal force due to the rotative motion is

$$\rho\omega^2 R^2\, dR\, d\phi\, dz$$

It acts the same as shown before. Finally, the two forces due to tangential stresses of viscosity are:

$$(\tau - d\tau)\, R\, dR\, d\phi$$

on the upper longitudinal section, and

$$\tau R\, dR\, d\phi$$

on the lower one.

The equilibrium of all these forces gives the expression after simplifying:

$$\rho\omega^2 R^2\, dR\, dz - R\, dp\, dz - p\, dR\, dz = -R\, d\tau\, dR \quad \ldots\ldots (1')$$

As before, we do two consecutive integrations and take into consideration the limit conditions:

$$z = 0,\ dv/dz = 0 \quad \text{and} \quad z = h/2,\ v = 0$$

Then we find the equations of the parabolic distribution of the velocity:

$$v = (1/2\mu)\ (dp/dR + p/R - \rho\omega^2 R)\ (z^2 - h^2/4) \quad \ldots\ldots (2')$$

We obtain the leakage value:

$$q = 2\int_0^{h/2} v\, ds$$

where:

$$ds = \phi R\, dz$$

or

$$q = 2\int_0^{h/2} (1/2\mu)\ (dp/dR + p/R - \omega\rho^2 R)\ (z^2 - h^2/4)\ \phi R\, dz$$

Computing the last integral, we obtain:

$$q = (-\phi h^3/12\mu)\ (R\, dp/dR + p - \rho\omega^2 R^2) \quad \ldots\ldots\ldots (3')$$

This expression is a linear equation which can be written:

$$dp/dR + p/R = \rho\omega^2 R - 12\mu q/\phi h^3 R$$

or

$$R\, dp/dR + p - \rho\omega^2 R^2 = -12\mu q/\phi h^3$$

The integral of this equation is:

$$p = (1/R)\ (C - \rho\omega^2 R^3/3 - 12\mu q\, R/\phi h^3)$$

Since pressure is practically zero at the inner radius of the land, R_4, and is constant and equal to p_0 at Radius R_3,

$$p = (\rho\omega^2 R^2/3)\ (1 - R_4^2/R_3^2) - (12\mu q/\phi h^3)\ (1 - R_4/R)$$

For the height of the clearance:

$$h^3 = \left[\frac{12\mu q}{\phi}\right] \frac{(1 - R_4/R_3)}{(\rho\omega^2 R_3^2/3)\ (1 - R_4^2/R_3^2) - p_0} \quad \ldots\ldots\ldots (4')$$

Also:

$$p = (\rho\omega^2 R^2/3)\ (1 - R_4^2/R_3^2) - \frac{R_3\ (R - R_4)\ [(\rho\omega^2 R_3^2/3)\ (1 - R_4^2/R_3^2)]}{R\ (R_3 - R_4)} \quad \ldots\ldots\ldots (5')$$

The above derivations neglected:

a) Forces due to pressure drop periferally between the two orifices (both sides between the inlet and discharge ports).

b) Forces created by hydrodynamic friction in the rotary motion of the rotor which undoubtedly drives with it some leaking fluid.

Leakage flow was assumed to spread radially between the lands. Because the neglected forces are small compared to the computed ones, and width of the land is usually relatively small, these assumptions do not introduce a considerable error.

At common pump speeds, we can also neglect centrifugal force, reducing the equation to:

$$p \cong p_0\ (R_1 - R)/(R_1 - R_2) \quad \ldots\ldots\ldots (6)$$

for the external land,
and

$$p \cong \frac{p_0 R_3\ (1 - R_4/R)}{(R_3 - R_4)} \quad \ldots\ldots\ldots (6')$$

for the internal land.

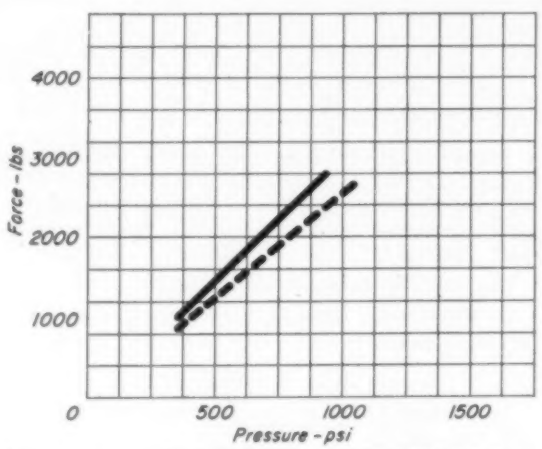

FIG. 4. FORCE pushing rotor against port plate. Dashed line is calculated force; solid line is experimental force.

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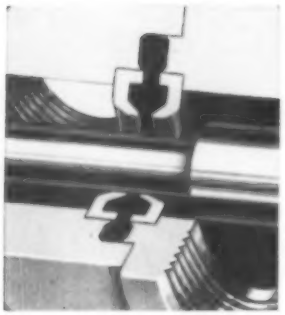

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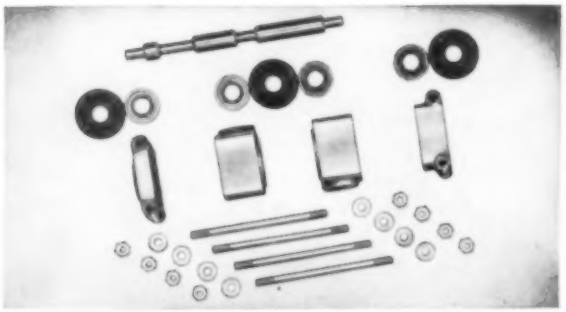

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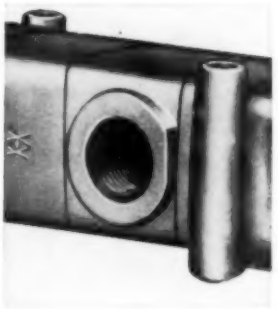

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PUMP DESIGN BY FORCE BALANCE

• **Resultant Hydraulic Force on the Port Plate**—Hydraulic force is

$$F = pS$$

where: p = pressure acting on surface S.

In differential form:

$$dF = pdS$$

In our case, pressure on the port plate lands is given by equations (6) and (6¹).

The elementary surface in polar coordinates is

$$dS = R\ dR\ d\phi$$

giving

$$dF = pR\ dR\ d\phi \quad \ldots\ldots (7)$$

To obtain the full hydraulic force exerted by the pressure of the leakage fluid, we have to integrate equation (7) separately for the outside land limits and the inside ones, and sum the results. We then obtain:

$$dF = R\ dR\ d\phi\ [p_0\ (R_1 - R)/(R_1 - R_2)]$$

for the outside land in the limits $R = R_1$, $R = R_2$, and $\phi = -\phi/2$; $\phi = +\phi/2$. This integration is a simple one and gives the result:

$$F' = \phi p_0/(R_1 - R_2)\ [(R_1^2/6 - R_2^2\ (R_1/2R_2 - 1/3)] \quad \ldots (8)$$

Equation (7) for the inside land gives:

$$dF = [p_0\ R_3/(R_3 - R_4)]\ (1 - R_4/R)\ R\ dR\ d\phi$$

Here the integration limits are:

$$R = R_3,\ R = R_4 \text{ and } \phi = -\phi/2,\ \phi = +\phi/2$$

The result of this is given by the expression:

$$F'' = (p_0\ R_3\ \phi/z)\ (R_3 - R_4) \quad \ldots\ldots (8')$$

Finally the total hydraulic force is given by:

$$F_1 = F' + F''$$

• **Other Forces Acting on the Port Plate**—Besides the hydraulic forces computed above, there are also the following forces acting on the port plate surface:

a) Force due to the pressure on the discharge orifice. This force also tends to separate the rotor and the port plate. It may be computed easily by the simple equation:

$$F_2 = p_0 S$$

where: S = Surface of the discharge port

$$S = [\phi\ (R_2 + R_3)/2]\ (R_2 - R_3) \quad \ldots\ldots (9)$$

Therefore:

$$F_2 = p_0\phi/2\ (R_2^2 - R_3^2) \quad \ldots\ldots (10)$$

b) Force of the pistons. All the forces derived above tend to separate the rotor from the port plate. The only force holding them together is the resultant force exerted by the pistons through the compressed fluid. The only pistons which act together are those which are discharging. Pumps are usually built with an odd number of pistons to minimize pulsation. Therefore the number of pistons exerting force will be either

$$(n - 1)/2 \quad \text{or} \quad (n + 1)/2$$

where: n = Number of pistons

For example, if the rotor has seven pistons, either three or four will act together. To compute force on the port plate, we take the lower number of pistons. Resultant force is then:

$$F_3 = [(n - 1)/2]\ p_0\ Sp \quad \ldots\ldots (11)$$

where: Sp = Piston surface

• **Sizing the Port Plate**—All the forces noted above must be in equilibrium. Therefore, the basic equation for sizing the port plate is

$$F_1 + F_2 - F_3 = 0 \quad \ldots\ldots (12)$$

This equation should give the ideal relations between the port lands. But, because force produced by the pistons has a variable, pulsating character, and because of assumptions made in the derivations, the pistons force should be predominant for quiet and non-pulsating performance. This net force should then be balanced by a thrust bearing.

To determine dimensions of the port lands, we follow these steps:

a) The number of pistons and their diameter is found from the desired output and the pulsation degree allowed.

b) The diameter of piston centers is determined to make maximum use of the available space. The use of at least 75% of the perimeter of the center line circumference is a good rule. We can then define the main diameter of the discharge port and have:

$$D_m/2 = (R_2 + R_3)/2$$

c) The width of the discharge port annulus can be found from the allowable fluid velocity through it, and the pump delivery.

$$S = q/v = \phi R_m\ (R_2 - R_3)$$

Hence with the total angle ϕ given from the construction, we can find:

$$R_2 - R_3 = q/v\phi R_m$$

$$R_m = D_m/2$$

Then we can determine the radii of the discharge port R_2 and R_3.

d) From the construction, we assume a land width, giving the dimensions R_1 and R_4. Then we check the equilibrium of forces by equation (12). In choosing the width of the port lands, it is a good rule to make the inner land about 75% to 80% of the outer land. Accordingly, to the result of equation (12), we change the land width, increasing it if the piston's force is predominant, or decreasing it in the opposite case. Generally two, or at least three trials are sufficient to get the correct sizes.

Because of approximations in this method, some actual testing will still be necessary in developing a pump. But, if these equations help the designer to understand the factors involved better and to find out causes of troubles, and if they reduce actual testing, they have achieved their purpose. ▼▼▼

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The value and speed of pressure surges depend on fluid bulk modulus and density, and on fluid velocity change.

Calculating critical pressure surges

• By **DIETER E. A. TANNENBERG, P. E.**
Supervising Engineer, Test Engineering, Flexonics Div. of Calumet & Hecla, Inc., Bartlett, Ill.

HYDRAULIC pressure surge is a critical factor in the design of hydraulic systems equipped with fast acting valves. Designers often incorporate a large safety factor to insure continued operation at pressure impulse peaks 1½ to 2 times operating pressure. Many design specifications for high pressure hydraulic system components give requirements based on unrealistic extrapolations of hydraulic surge pressures obtained in low pressure systems.

• **Cause and Effect of Hydraulic Surge**—When a hydraulic valve is closed quickly, the column of fluid which is stopped suddenly upstream from the valve dissipates its kinetic energy by compressing the fluid and stretching the fluid line walls. A compression wave of increased pressure is transmitted upstream through the fluid, starting at the valve and continuing with a theoretically constant intensity and velocity.

Though surge pressure is not concentrated at the valve, the valve may fail simply because pressure acts there first. The velocity of propagation of a pressure wave is equal to the velocity of sound through the fluid, neglecting the effect of the elastic fluid line walls and the viscous damping of the fluid.

The pressure increase due to the sudden closing of the valve, is proportional to the absorbed velocity of the fluid and the velocity of propogation of the compression wave. Surge pressure will be the same whether caused by a sudden change in fluid velocity or a complete stoppage of fluid flow, whether the velocity drops from 20 to 10 fps or from 10 to 0 fps, assuming that both changes take place in equal time.

Continued on page 110

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MEASURING HYDRAULIC PRESSURE SURGES

The compressibility of a hydraulic fluid is measured as the *Bulk Modulus of Elasticity*. This property of fluids is expressed as:

$$K = \frac{P}{\Delta V/V} = \frac{PV}{\Delta V} \qquad (1)$$

where: K = Bulk modulus of elasticity, psi
P = Change in pressure, psi
V = Initial volume
ΔV = Volume change necessary to raise initial pressure by amount P

The bulk modulus of elasticity of a fluid is a function of pressure and temperature. The valve at a given average pressure and temperature may be used to solve pressure surge problems.

Two methods may be used to calculate the pressure and the subsequent propagation velocity of the pressure wave caused by the sudden closure of a valve. The first will assume that the fluid line is rigid. The second will consider the elasticity of the fluid line material.

• **Rigid Fluid Line**—Excess pressure p, and velocity of propagation c, due to the sudden stop of fluid flow are:

$$p = v\sqrt{\frac{Kw}{144\,g}} \qquad (2)$$

and

$$c = \sqrt{\frac{144\,g\,K}{w}} \qquad (3)$$

where: p = Excess pressure, psi
v = Velocity of propagation, ft/sec
c = Initial velocity less final velocity of fluid, ft/sec
w = Fluid density, lb/cu ft
g = Acceleration due to gravity, 32.2 ft/sec²

• **Elastic Fluid Line**—Excess pressure p, and velocity of propagation, c, due to the sudden stop of fluid flow are:

$$p = v\sqrt{\frac{w}{144\,g} \times \frac{(K\,E\,t)}{(tE + dK)}} \qquad (4)$$

and

$$c = \sqrt{\frac{144\,g}{w} \times \frac{K\,E\,t}{(tE + dK)}} \qquad (5)$$

where: E = Young's modulus of elasticity of the fluid line, psi
t = Fluid line wall thickness, in.
d = Fluid line ID, in.

By comparing equations (2) and (4), an equivalent bulk modulus of elasticity may be derived for a fluid flowing in an elastic fluid line. This modulus of elasticity K_e, will be equal to or less than the value of K for the fluid:

$$K_e = \frac{K\,E\,t}{(tE + dK)} \qquad (6)$$

In both cases, hydraulic surges will take place only if the valve closing time is less than twice the fluid line length upstream from the valve, divided by the propagation velocity of the pressure wave:

$$T = \frac{2\,L}{c} \qquad (7)$$

where: T = Closing time, sec
L = Fluid line length, ft ▼▼▼

HOW HYDRAULIC HAMMER COMPARES IN HIGH AND LOW PRESSURE SYSTEMS

The current trend in industrial hydraulics is toward higher pressure systems using smaller components. Here is a comparison between two 35-hp hydraulic systems. One delivers 10 gpm at 6000 psi, the other 60 gpm at 1000 psi.

In these two systems of equal power output, the effect of hydraulic surge in the high pressure system can be considered less critical than in the low pressure system. By calculating all design parameters, including hydraulic surges, the engineer can avoid higher costs through proper design of component size, weight, and strength to fit actual rather than extrapolated conditions.

	High	Low
Operating pressure, psi	6000	1000
Flow rate, gpm	10	60
Hydraulic horsepower	35	35
Tubing ID, in.	0.50	1.25
Tubing wall thickness,* in.	0.11	0.058
Fluid velocity, ft/sec	16.4	15.7
Tubing length, ft	40	40
Fluid bulk modulus, psi	250,000	250,000
Fluid density, lb/ft³	53	53
Equivalent bulk modulus, psi (E = 30,000,000 psi) (Eq. 6)	241,000	218,000 from eq. (6)
Propagation velocity, ft/sec	4,590	4,370 from eq. (5)
Valve closure time, sec	0.0174	0.0183 from eq. (7)
Excess pressure due to rapidly closing valve, psi	860.7	783.5 from eq. (4)
Peak pressure (operating plus excess) psi	6860.7	1,783.5
Percent of operating pressure, %	114.4	178.8

*based on 30,000 psi allowable stress and a safety factor of 2.

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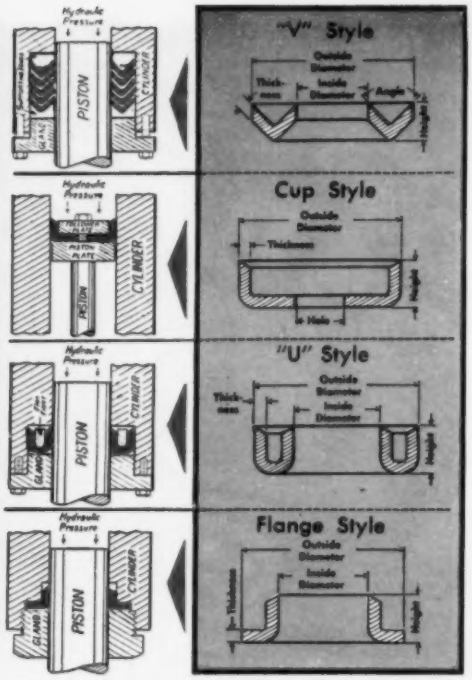

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Each hydraulic or pneumatic cylinder designer has a specific task in mind when engineering a particular hydraulic assembly. Page takes the position that it has the responsibility to engineer the packings to meet the requirements of the design. To produce these custom packings it is essential to have full specifications and operating conditions. The following data is most important in determining proper dimensions, leather tannage and leather treatment.

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12	"U"	Static	100° F	5,000 lbs.	Hot Water	20"	18⅝"	3/16"	1¼"

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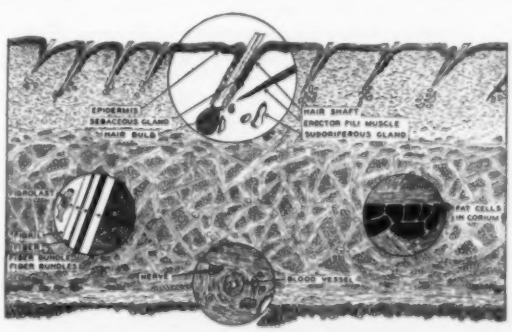

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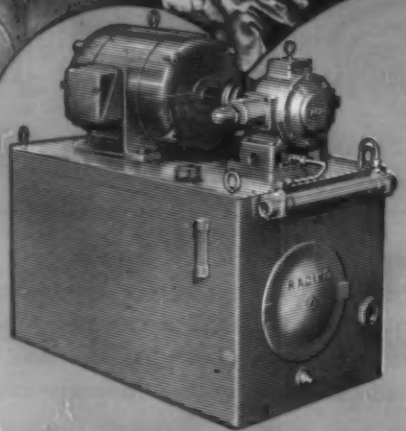
"This is the first time that a spider for a universal joint has been machined in direct transfer of the part itself rather than by pallet transfer," says William Defibaugh, Vice President and Chief Engineer of Drillunit, Inc. The new unit is only half the size of any previous spider transfer machine. Clamping and unclamping the spider are governed by 5 RACINE Model 4FA Pumps, each one a self-contained power unit with its own reservoir. A sixth 4FA unit controls movements which turn, probe and transfer the part from station to station. To complete the hydraulic package, 24 RACINE Model Q Pumps serve the standard self-contained drill units. R. S. Naeyaert, President, adds, "RACINE flexibility in delivering pressurized oil in *variable volume* at *varying pressures* make it the ideal choice."



The HEARTS of this automotive transfer operation are the compact RACINE *Power Units equipped with*

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RACINE, WISCONSIN
HYDRAULICS DIVISION

Circle **126** on Reader Service Card

Air/oil booster powers prototype presses

By **WILLIAM F. FELL,**
Staff Engineer, Jack & Heintz Co., Cleveland, Ohio

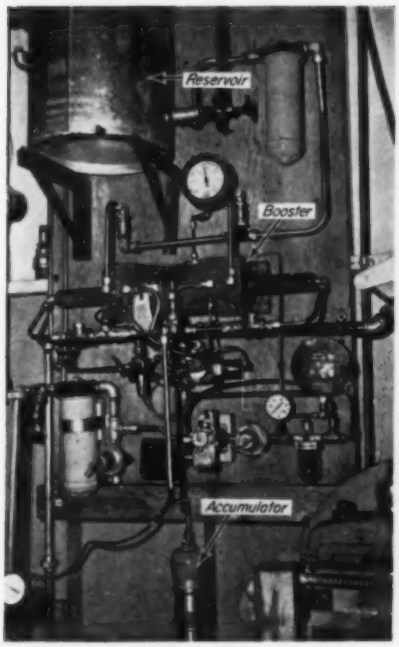
and **TERRY MORRIS,**
Miller Fluid Power Division of Flick Reedy Corp. Bensenville, Ill.

HOW do you avoid the expense of making production dies and tying up large plastic and rubber presses for small manufacturing runs and prototypes? Here's the solution—built a hydraulic power source for your pneumatic prototype presses.

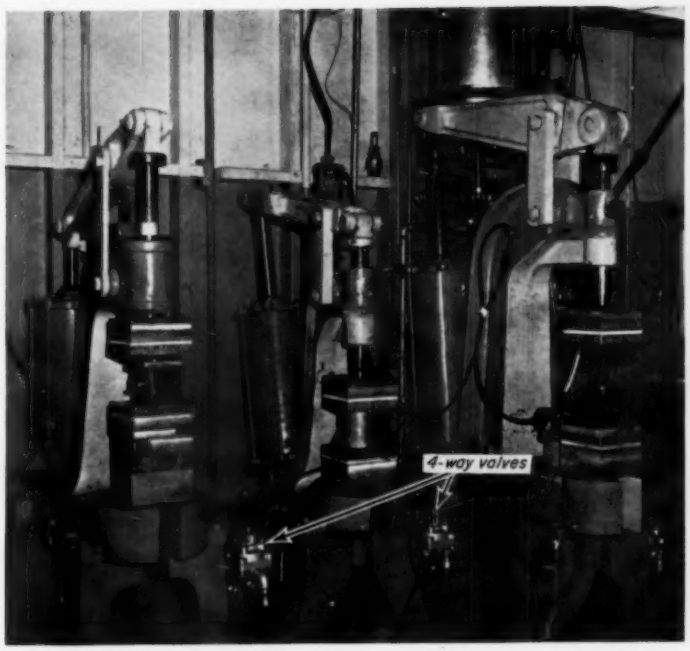
Jack & Heintz have three presses in their hydraulics materials fabrication department. Each has a cylinder rated at 250 psi hydraulic pressure. Shop air pressure is only 80 psi. So the problem was to convert 80-psi air to 250-psi hydraulic pressure. Solution: a reciprocating air/oil booster.

• **Pressure Switch Controls Air Supply**—The system uses a double-rod-end booster, reciprocated by a remote, double pilot-operated air valve. The reservoir is mounted above the presses and pressurized with 15-psi air. This provides oil under pressure to the booster and prevents air being drawn into the system. A relief valve in the oil pressure line limits maximum system pressure.

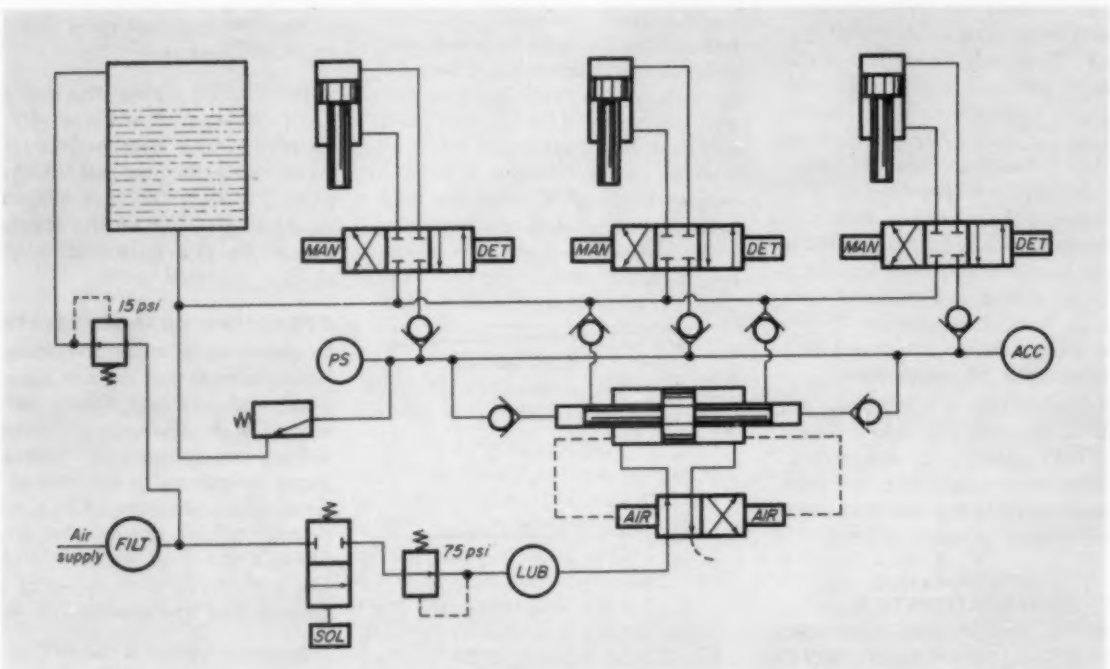
A pressure switch in the high pressure oil line controls a solenoid shutoff valve. The switch



PRESSURIZED RESERVOIR supplies fluid to reciprocating air/oil booster. Accumulator in the booster output line dampens pulsations.



ROTARY 4-WAY VALVES direct fluid to and from the press cylinders. Cylinder force is increased through a linkage connecting it to the ram.



PRESSURE SWITCH in the booster output circuit opens the solenoid valve in the booster air circuit when system pressure falls to a set minimum. A pressure regulating valve maintains 15-psi air pressure in the reservoir.

opens the valve and directs air to the booster if system pressure falls to a set minimum.

Check valves hold pressure to each press when the other presses are being used. A piston type accumulator dampens any pulsations in the high pressure circuit caused by the reciprocating booster. ▼▼▼

Performance, application and operating characteristics of new 2500 psi hydraulic vane pumps

By: Robert A. Manogue
Pumps/Controls Product Manager
Denison Engineering Division
American Brake Shoe Co.

In designing hydraulic circuits, it is normal to limit line velocities to a maximum of from 15 to 20 feet per second. This permits the use of the smallest practical lines, valves and fittings. Pressure drop in transmitting the fluid is thus dependent on flow velocity, number of valves and fittings and line length. For example, if the pressure drop of a given system is 50 psi, it represents a loss in transmission of 5% for a 1000 psi system and a loss of only 2% for a 2500 psi system. Power loss in transmission is reduced 60% by using 2500 psi components.

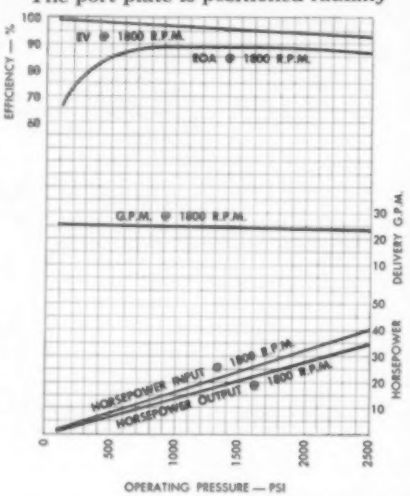
Net advantage is a more efficient hydraulic system with lighter weight and less cost-per-horsepower in smaller, more easily installed components than is possible with comparable lower pressure systems.

PERFORMANCE CHARACTERISTICS

Based on these inherent advantages for 2500 psi, Denison has engineered and produced a new series of "T1C" vane pumps with rated deliveries of 8, 11, 14 and 17 gpm at 1200 rpm and zero psi. Major considerations in designing the new pump were: Higher efficiency, speed and pressure for continuous duty to 2500 psi and 2500 rpm—as well as lower cost, ease of maintenance and compactness. The T1C pump shaft will support a radial load of 479 pounds at the center of the keyway.

PUMP CONSTRUCTION

The pump is a "cartridge" type design for quick, convenient servicing. It consists of a housing which provides an inlet connection, a bore for support of the shaft bearing and shaft assembly. The lip-type shaft seal is located outboard of the front bearing in the housing to permit bearing lubrication, using the fluid being pumped. A larger bore contains a floating front port plate, spring-loaded against the cam ring. The port plate is positioned radially by a dowel pin between the housing and port plate. The cam ring is located in a close-fitting bore and positioned radially by a dowel pin between the end cap and cam ring. Besides retaining the cam ring in the housing, the end cap contains suction and pressure cores and the outlet connection.



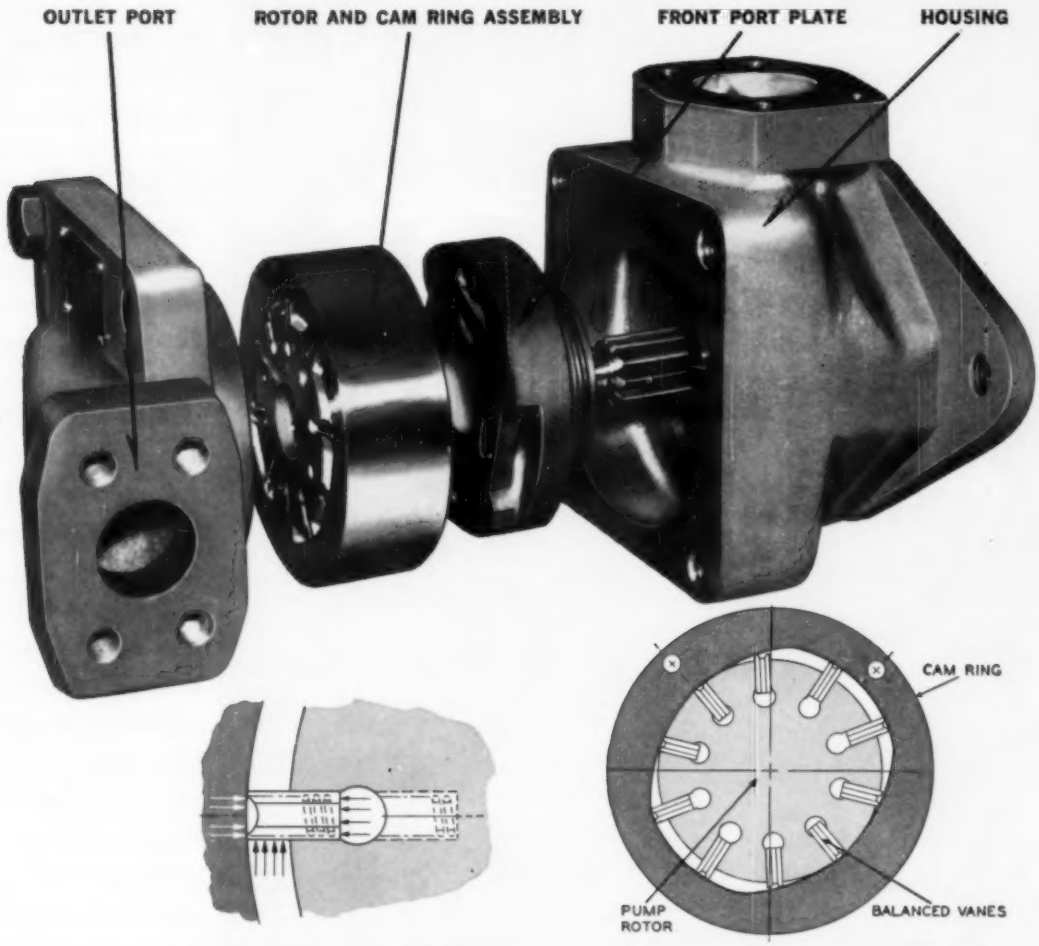
PERFORMANCE CURVES *demonstrate high volumetric efficiency of new 2500 psi Denison vane-type hydraulic pumps.*

To simplify piping, the end cap can be rotated to any one of four positions. The port pads on the pump match the four-bolt SAE port pads. An SAE "B" size mounting flange is provided on the standard pump. An alternate SAE splined shaft is available.

OPERATING CHARACTERISTICS

In operation, oil enters the pumping cavity through cast ports in the port plate and end cap. Oil is carried around to the discharge ports in the end cap and out the outlet port. The pump is internally drained at all times. The end cap contains a cored passage behind the bearing which allows a flow of oil through the bearing back to suction, keeping the bearing cool and minimizing wear.

A unique feature of the T1C pump is the floating front port plate which is free to move axially within limits. It utilizes hydraulic pressure to counteract internal hydraulic pressure that tends to separate the elements of the pumping cartridge after the pump is primed and delivering pressure to the circuit. A light spring



BALANCED OPEN-END VANE DESIGN
assures low wear through continuous pressure balancing which relieves hydraulic bearing loads between vanes and cam ring.

ROTOR AND CAM RING ASSEMBLY
with large inlet ports for improved suction characteristics. Rotor is balanced axially and radially for consistently high volumetric efficiency and long life.

is used to hold the pumping cartridge together when there is no pressure in the system and for starting. The floating plate construction minimizes scoring the wear faces on the front port plate and the end cap.

Oil flow in the pump is always from the inlet in the housing to the outlet in the end cap. Shaft rotation may be changed by simply repositioning the cam ring. Arrows indicate desired direction of rotation. The pump can be either flange or bracket mounted.

Other characteristics include: Oil, 150-300 SSU @ 100°F. Viscosity index, 90 or above. Minimum running viscosity, 65 SSU. Maximum viscosity at starting temperature, 7500 SSU. Data was determined with petroleum base oils.

APPLICATIONS

Among particularly suitable applications for new T1C pumps are: Mobile equipment—including earth-moving units, trucks, buses, tractors and power shovels where 2500 psi power can mean lower weight, increased payloads and greater user operating profit. Special machinery—including extrusion presses where the compact pump puts more power into less space. Automated production equipment—where feed circuits and index mechanisms benefit through the increased operating efficiency and low maintenance of 2500 psi hydraulics.

DESIGNERS and ENGINEERS

New 8-page Bulletin 200A includes specifications, performance and operating application data on new 2500 psi Denison balanced-vane hydraulic pumps. Write for your copy.

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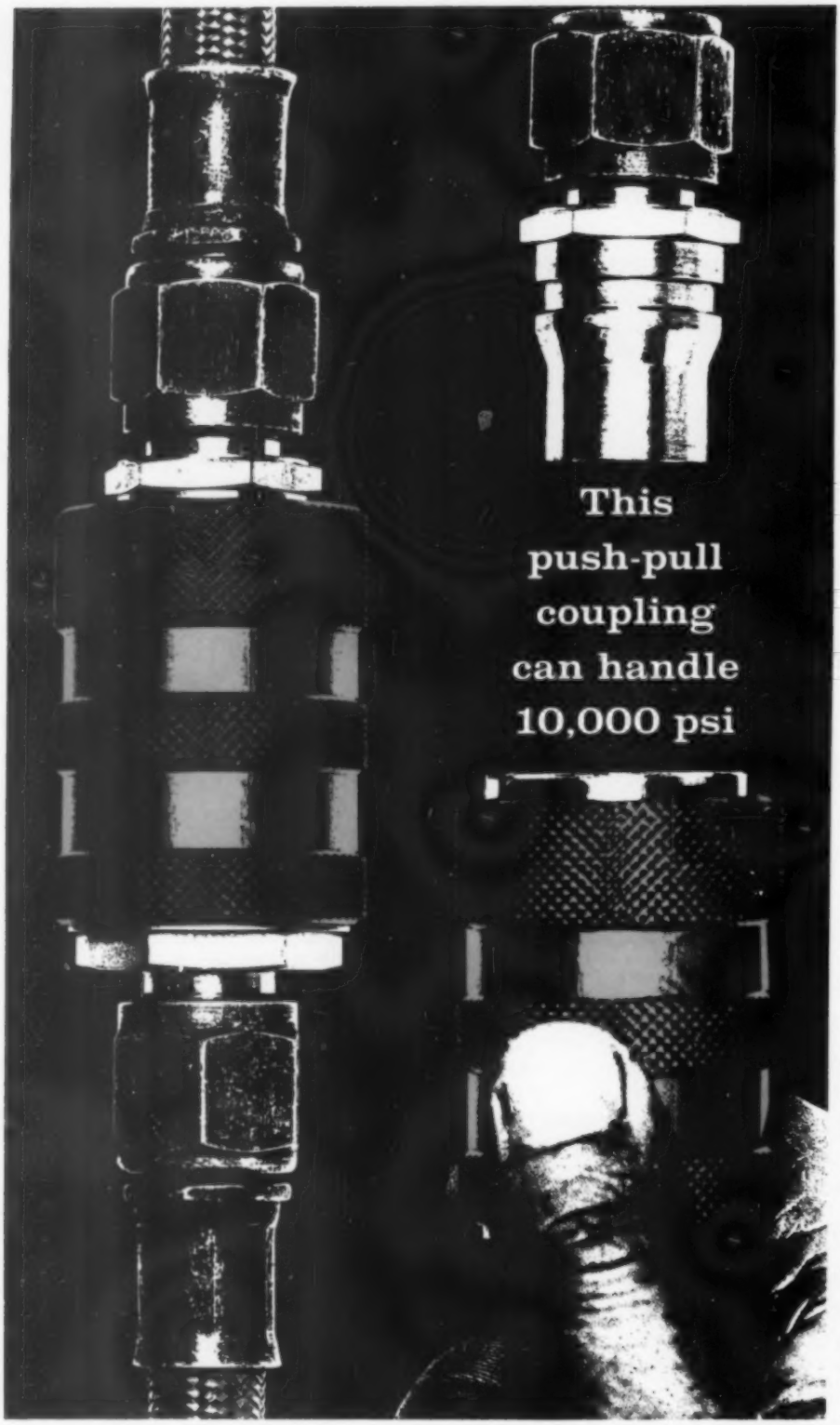

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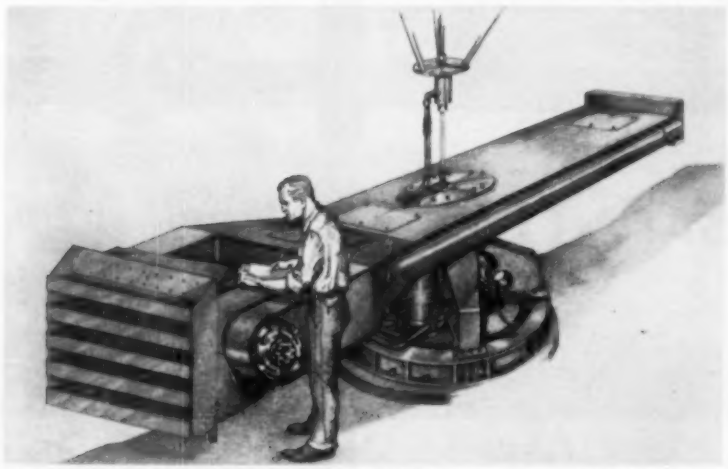
AEROSPACE SECTION

Fluid Systems For Flight and Ground Support

Centrifuge Simulates Rocket Acceleration



CENTRIFUGE ACCELERATION TEST MACHINE will carry an individual specimen package of several hundred pounds up to 150 g's.

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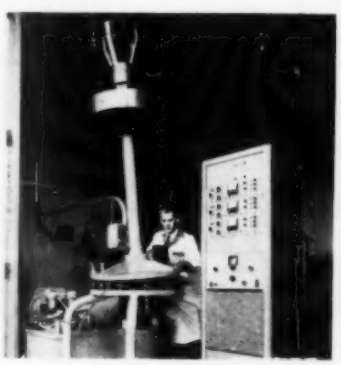
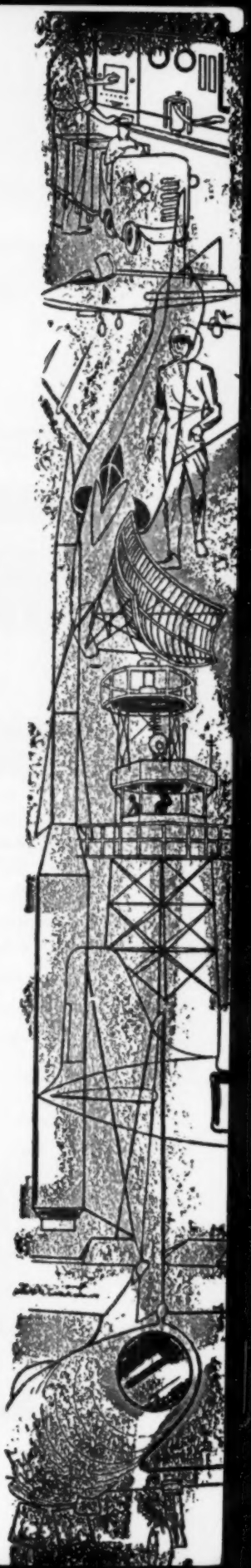
A contract for the design, manufacture, and installation of a centrifuge acceleration test machine for Sandia Corporation's Livermore Laboratory has been awarded to The Rucker Company, Oakland. The machine will simulate environmental g-forces encountered in rocket acceleration and flight, to test components under controlled conditions.

It will have a variable hydraulic drive system and a hydraulic, programmed servo control, specially designed to simulate flight conditions. The basic unit which includes the powerhead, arm assembly, and specimen platform is mounted in a 24-foot diameter, concrete-lined pit.

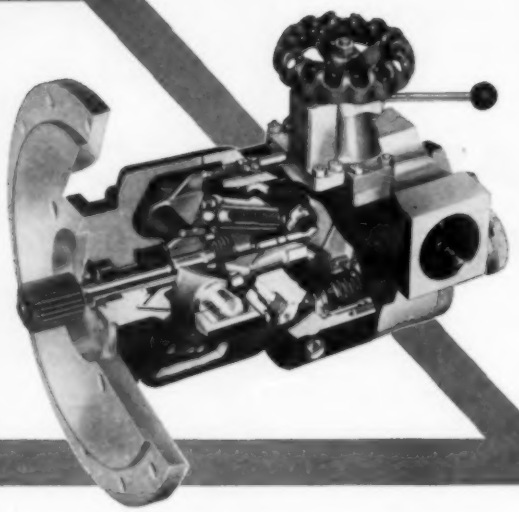
Simulator Floats on Hydrostatic Bearing

Although it weighs two tons, this space vehicle simulator can be set in motion with the light touch of one finger. The entire unit, with the exact mass and moment distribution of a simulated space vehicle, is supported on a steel ball. The ball floats in a hydrostatic bearing supplied with oil from a standard hydraulic pump. Vickers Incorporated designed and built the simulator under a NASA contract.





Nine piston, variable volume, pressure compensated type IA-38-9 pump, designed for use on Ground Support Equipment.



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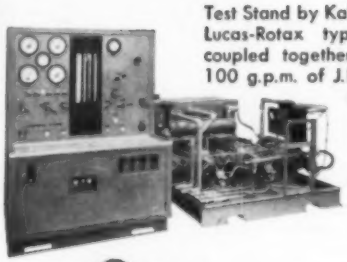
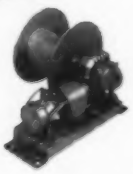


Test Stand by Kahn Company. Three Lucas-Rotax type IP-525 pumps coupled together provide flow of 100 g.p.m. of J.P.4 fuel for testing aircraft equipment.



Marine winches by Timberland-Ellicott are powered by Lucas-Rotax pumps and motors.

Two IA-38 pumps are incorporated in the portable Test Stand by Consolidated Diesel for use in checking out hydraulic system components on fighter aircraft at 5,000 p.s.i.

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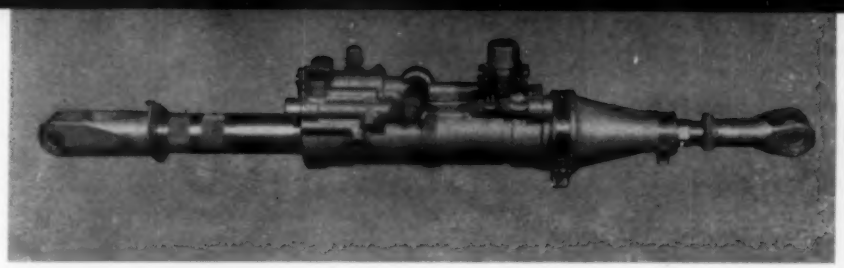

FIG. 1. SERVO ACTUATOR, 40 inches long with a 12,000-lb. force, carries a 152-slug load mass while gimballing an engine on a large space vehicle.

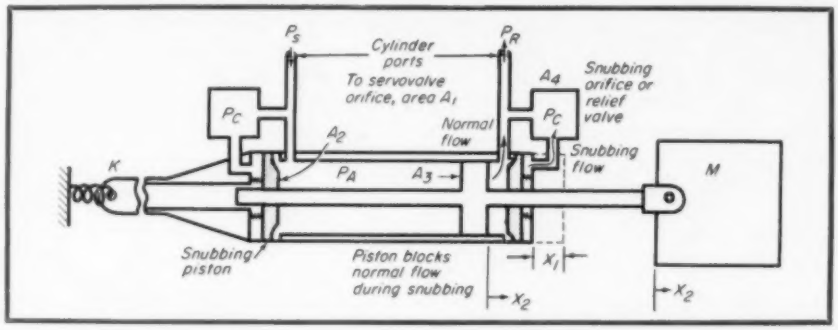

FIG. 2. SERVO ACTUATOR AND SNUBBING SYSTEM. Schematic presents a possible snubbing system. Note that the type of restriction is not specified. This makes the graphical technique applicable to other snubbing designs.

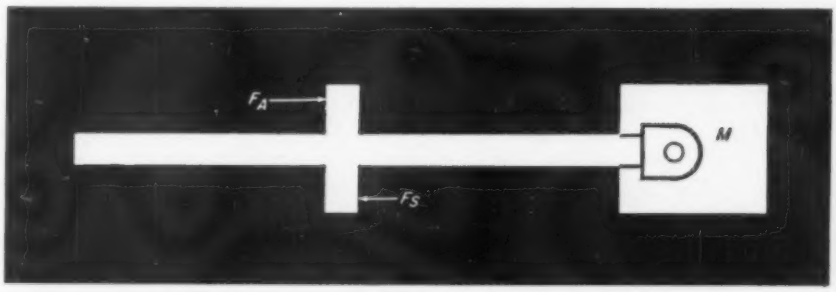

FIG. 3. FREE BODY DIAGRAM OF PISTON ROD AND LOAD MASS. The actuator's mass is negligible compared to the load mass.

Use graphs for optimum snubbing design

For servo actuators in high response, high inertia systems, some provision must be made to snub system kinetic energy when the piston bottoms. Without snubbing, structural overdesign will be necessary. Failure to optimize results in a considerably longer, heavier servo actuator.

• By **ROBERT L. WARREN,** *Lead Engineer*
Servo Controls Section L-T-V Electronics, Dallas, Texas

TO DISSIPATE a given amount of energy, the optimum snubbing system has a minimum snubbing load, snubbing stroke, and snubbing pressure. With the graphical technique explained in this article, the designer controls snubbing load, stroke, and pressure parameters to create an optimum design within the framework of any specification. This direct, graphical approach to the solution of the non-linear differential equations has been proven accurate in an analog computer study at Vought Electronics. The technique has been used in the design of snubbing systems for engine gimballing servo actuators on the first stage of a large space vehicle, and for servo actuators driving a large shake-table used for testing sections of an ICBM.

• **Snubbing Flow-Through Restriction**—A schematic diagram of a linear servo actuator carrying a large load mass is shown in Figure 2. The actuator is grounded through a structural spring at one end. Snubbing oc-

USE GRAPHS FOR OPTIMUM SNUBBING DESIGN

curs when the actuator piston covers a cylinder port. Then the snubbing piston at the end of the actuator forces fluid through a restriction back to the cylinder port line. The kinetic energy of the load mass is partially expended as the actuator piston forces the snubber pistons to expel fluid through the restrictions. This diagram represents a possible snubbing system design. The type of restriction is unspecified. The restricted flow is forced back through the servovalve. It could possibly be forced directly to return. The snubbing pistons are shown merely to illustrate that the flow from the cylinder must be diverted through a restriction during the snubbing stroke. The mass of the actuator is negligible compared to the mass of the load. Structural damping is neglected because it is not constant and is difficult to estimate. It may be considered a bonus toward meeting the snubbing requirements.

SYMBOLS

Symbol	Definition	Units	Value in example
P_S	System pressure	psi	3000
P_R	Return pressure	psi	75
P_A	Actuator load pressure	psi	—
P_C	Snubbing pressure	psi	—
ΔP	Pressure drop across servovalve	psi	—
F_A	Actuator force	lb	—
F_S	Snubbing force	lb	—
F_I	Impact load, when piston contacts snubber	lb	—
F_B	Bottoming load, when piston stops at end of snubbing	lb	—
σ	Coulomb friction force	lb	200
M	Load mass	slugs	152
X_1	Barrel displacement	in.	—
X_2	Load and piston displacement (snubbing stroke)	in.	—
$K_V = \frac{dx}{dt}$	Velocity (1st derivative of X)	in./sec.	—
$X_A = \frac{d^2x}{dt^2}$	Acceleration (2nd derivative of X)	in./sec.^{2}	—
K	Structural spring rate	lb/in.	72330
A_1	Effective servovalve orifice area	in.^{2}	1.19×10^{-2}
A_2	Snubbing piston area	in.^{2}	5.16
A_3	Actuator piston area	in.^{2}	4.06
A_4	Snubbing orifice area	in.^{2}	1.039×10^{-2}
Q	Flow through servovalve	in.^{3}/sec.	—

TABLE OF CALCULATIONS

X_{2V}	MX_{2A}	M	X_{2A}	t_1	t_2	$t_1 + t_2$*
12.0	9000	152/12	710.5	.0169	0	.0169
11.5	7400	152/12	584.2	.0197	.0008	.0205
11.0	5800	152/12	457.9	.0240	.0017	.0257
10.5	4200	152/12	331.6	.0317	.0029	.0346
10.0	2700	152/12	213.5	.0468	.0044	.0512
9.5	1400	152/12	110.9	.0860	.0066	.0927
9.0	0	152/12	0	—	—	—

*Time axis intercept of tangent slope.

• **Inertial Load is Dissipated**—Figure 3 is a free body diagram of the piston rod and load mass assembly immediately after striking the right snubbing piston in Figure 2. The inertial load in the piston rod is the difference between the actuator force and the snubber force, and may be written (following the general equation force = mass x acceleration)

$$F_A - F_S = MX_{2A} \quad \ldots\ldots\ldots (1)$$

where MX_{2A} is the inertial load.

The inertial load may be dissipated through the structural spring and through snubbing. However, if no snubbing is provided, the entire kinetic energy in the system must be transferred into the potential energy of structural spring deflection if the moving system is to be stopped by the structure. We may write the energy balance as

Kinetic energy = Potential energy

$$\tfrac{1}{2} M X_{2V}^2 = \tfrac{1}{2} K X_1^2$$

from which

$$X_1 = \sqrt{\frac{M}{K}} X_{2V} \quad \ldots\ldots (2)$$

If there is no snubbing, the rod load developed, F_{max}, will be maximum. This load will have to be absorbed by the structural spring according to

$$F_{max} = K X_1$$

or, substituting from equation (2)

$$F_{max} = \sqrt{K M}\ X_{2V} \quad \ldots\ldots (3)$$

• **Correct Boundary Conditions**—It is possible to solve equation (1) for F_I, the impact load when the piston contacts the snubber, and to solve equation (3) for F_B, the bottoming load when the piston stops at the end of snubbing travel. To solve these equations, the correct boundary conditions must be placed on F_A and F_S at time zero, and on X_{2V} when snubbing travel is completed.

Continued on page 123

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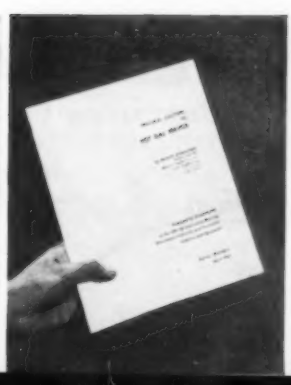

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Non-linear, differential equations may be written for F_A and F_S as function of piston velocity. Subtracting F_S from F_A graphically yields the inertial load MX_{2A} as a function of piston velocity. From this curve, the impact load caused by the collision between piston and snubber may be read directly for any impact velocity. To find the proper value of piston velocity X_{2V} at the completion of the snubbing travel, for substitution in equation (3), a plot of X_{2V} as a function of time must be constructed. This curve may then be graphically integrated to give X_2 as a function of time. Using these two curves, a final value of X_{2V} may be chosen corresponding to any value of snubbing stroke, X_2. Substitution of this value in equation (3) will then yield the impact load when the snubber bottoms.

• **Optimum Snubber Stiffness**—Snubber impact and bottoming load lines may be plotted as functions of F_S. A stiff snubber will cause high impact loads and low bottoming loads. A soft snubber will cause low impact loads and high bottoming loads. Optimum snubber stiffness will cause equal impact and bottoming loads. Therefore, the optimum load is at the intersection of the impact and bottoming load lines.

• **Example of Snubbing Design**—A complete numerical example of the technique follows for a system similar to Figure 2. Snubbing restrictions are sharp-edged orifices.

The expression for the actuator force may be written as follows:

$$F_A = A_3 (P_A - P_R) - \sigma$$

where

$$P_A = P_S - (\text{Servovalve pressure drop})$$

$$= P_S - \left[\frac{A_3 (X_{2V} - X_{1V})}{110 A_1}\right]^2$$

where 110 is the orifice constant. This expression for valve pressure drop assumes the valve to be a sharp-edged orifice, and is therefore a solution of the orifice equation

$$Q = 110 A_1 \sqrt{\Delta P}, \quad \text{or}$$

$$\Delta P = (Q/110 A_1)^2$$

Continued on page 124

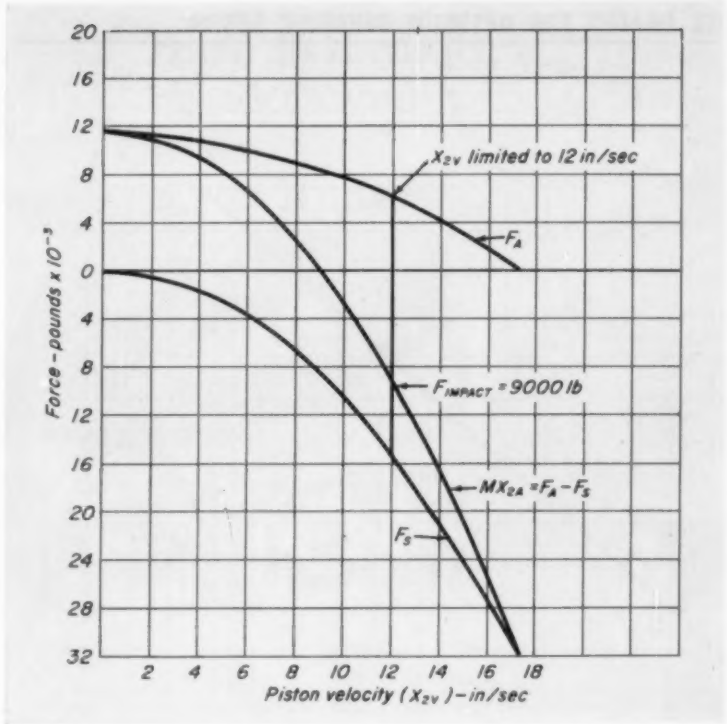

FIG. 4. ACTUATOR AND SNUBBING FORCE varies with piston velocity.

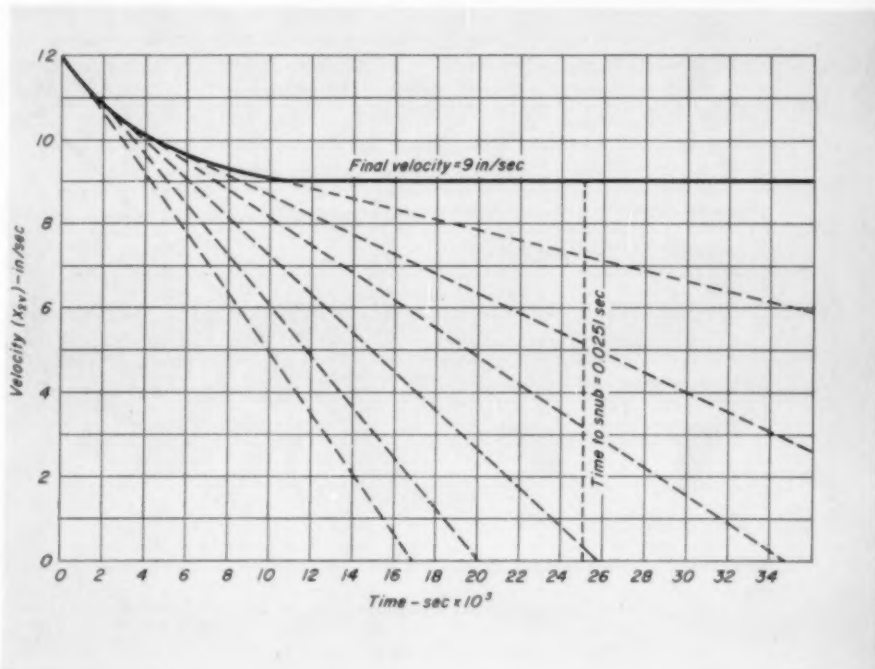

FIG. 5. ENVELOPE OF TANGENT LINES forms velocity curve.

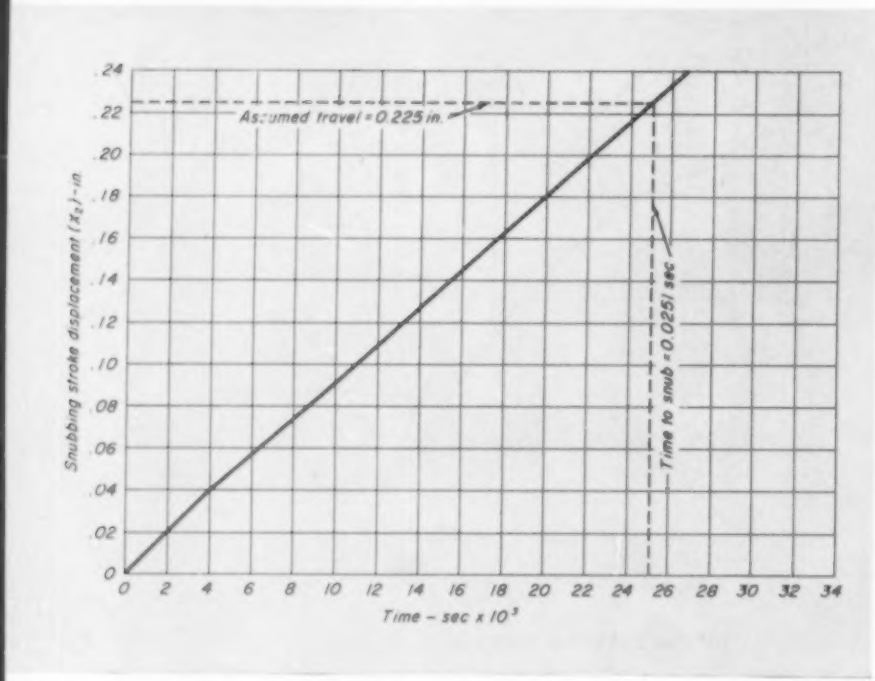

FIG. 6. SNUBBING STROKE. Integrating velocity curve from Figure 5 results in snubbing stroke displacement curve.

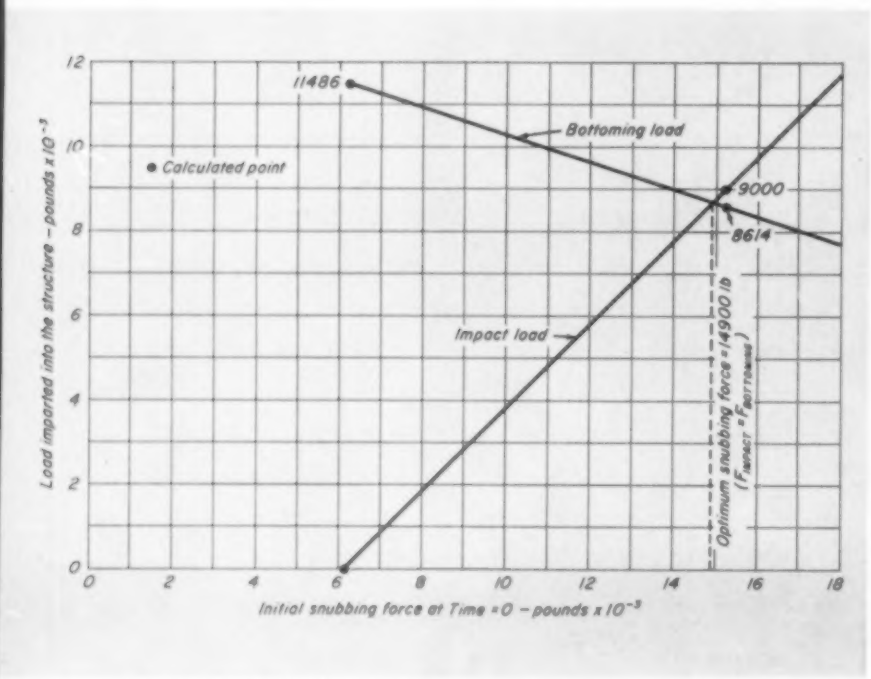

FIG 7. BOTTOMING AND IMPACT LOADS vary inversely. A greater impact load (more snubbing) results in a lower bottoming load.

$$F_A = A_1\left\{P_S - \left[\frac{A_2\,(X_{2V} - X_{1V})}{110A_1}\right]^2 - P_H\right\} - \sigma$$

$$= 4.06\left\{3000 - \left[\frac{4.06\,(X_{2V} - X_{1V})}{(110)\,(1.19)\,(10^{-2})}\right]^2 - 75\right\} - 200$$

$$F_A = 11676 - 38.8\,(X_{2V} - X_{1V})^2 \quad ..(4)$$

This equation is plotted in Figure 4.

The expression for the snubbing force may be written as follows:

$$F_S = P_C\,A_2$$

$$= A_2\left[\frac{A_2\,(X_{2V} - X_{1V})}{110A_1}\right]^2$$

where 110 is the orifice constant.

$$= 5.16\left[\frac{(5.16)\,(X_{2V} - X_{1V})}{(110)\,(1.039)\,(10^{-2})}\right]^2$$

$$F_S = 105\,(X_{2V} - X_{1V})^2 \quad \ldots\ldots\ldots\ldots(5)$$

This equation is plotted in Figure 4.

In the curves of Figure 4, the independent variable is X_{2V}. It is assumed $X_{1V} = O$, and that the structural spring has deflected an amount equal to the impact load $F_A - F_S$ at time = O, before snubbing starts. This boundary condition is valid because we assumed that the actuator mass is negligible.

The graphical difference between equations 4 and 5 is shown in Figure 4. The difference $F_A - F_S$ equals MX_{2A} from Equation (1). MX_{2A} is shown as a function of X_{2V}, piston velocity. Since M equals 152 slugs, a value for X_{2A} may be calculated for any value of X_{2V} as follows:

$$X_{2A} = \frac{MX_{2A}}{152/12} \text{ in/sec}^2 \quad \ldots\ldots\ldots(6)$$

where values for MX_{2A} are taken from Figure 4.

• Table Gives Calculations—The table shows the calculation of X_{2A} for values of X_{2V} from 12.0 to 9.0 in./sec.—the velocity where $F_A - F_S = O$ in Figure 4. The initial value of X_{2V} was selected as 12 in./sec. because of a flow limiter in the system set to limit velocity at that value. Without the flow-limiter, the initial value would have been 17.3 in./sec. maximum velocity.

Continued on page 126

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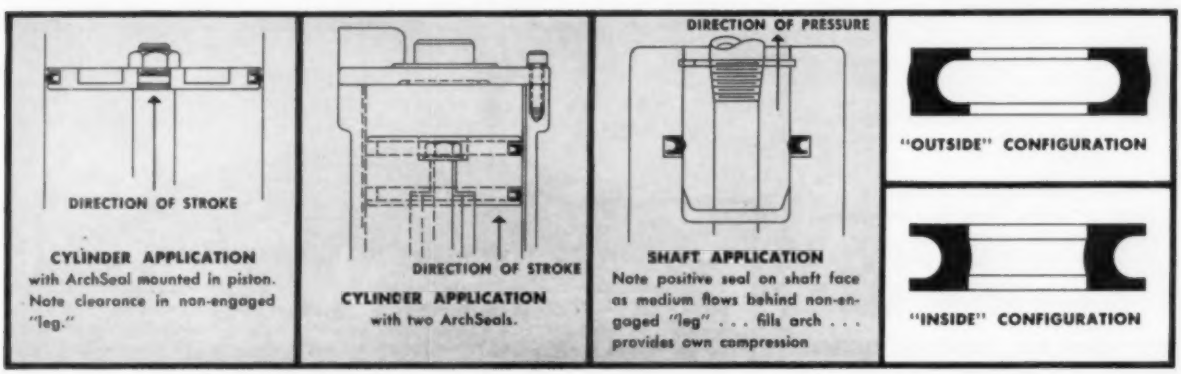
DIRECTION OF STROKE
CYLINDER APPLICATION
with ArchSeal mounted in piston. Note clearance in non-engaged "leg."
DIRECTION OF STROKE
CYLINDER APPLICATION
with two ArchSeals.
DIRECTION OF PRESSURE
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USE GRAPHS FOR OPTIMUM SNUBBING DESIGN

The curve of X_{2V} vs. time plotted in Figure 5 is obtained by successive plotting of X_{2V} and the corresponding incremental slope X_{2A}. This curve may be made quite accurate by taking small increments between successive values of X_{2V}. For example, in Figure 5, at $X_{2V} = 12.0$ in./sec., the tangent slope $= X_{2A} = 710.5$. Then $12.0/710.5 = 0.0169$ sec., the value for t_1 in the table. The values shown for t_2 in the table are the values of time at the tangent points. Hence, at $X_{2V} = 12.0$ in./sec., $t_2 = 0$.

The curve of X_2 vs. time plotted in Figure 6 is obtained by graphical integration of Figure 5. For example, for $X_{V2} = 11.5$ in./sec., the corresponding time $= 0.0008$ sec from the curve in Figure 5. Therefore the displacement X_2 in Figure 6 for 0.0008 sec will be $(12.0 + 11.5)/2 \times 0.0008 = 0.0094$ in.

• **How To Use Graphs**—To show how to use Figures 5 and 6, assume a snubbing stroke of 0.225 in. From Figure 6, 0.0251 sec are required to complete the stroke. From Figure 5, the velocity remaining at 0.0251 sec is 9.0 in./sec.

The bottoming load F_B at the end of snubbing travel may be calculated by substituting 9.0 in./sec. final velocity in equation (3) as follows:

$$F_B = X_{2V}\sqrt{KM} \text{ (final)}$$

$$= 9.0\sqrt{72330\ (152/12)}$$

$$F_B = 8614 \text{ lb}$$

The impact load F_I when the piston contacts the snubber may be read directly from Figure 4 at $X_{2V} = 12$ in./sec., and is:

$$F_I = 9000 \text{ lb}$$

The values of F_B and F_I above define points on the bottoming and impact load lines of Figure 7 for a snubber force of $F_S = 15{,}200$ lb (the value read from Figure 4 at $X_{2V} = 12$ in./sec.) Thus, if F_S were 6200 at $X_{2V} = 12$ in./sec., the impact load would be zero. Then the bottoming load would be calculated from equation (3) as follows:

$$F_B = X_{2V}\sqrt{KM}$$

$$= 12\sqrt{72330\ (152/12)}$$

$$F_B = 11{,}486 \text{ lb}$$

These values define the end points of the impact and bottoming load lines and are plotted in Figure 7 for $F_S = 6200$.

• **Intersection Is Optimum Value**—It may be shown that the load lines of Figure 7 are straight lines. When they are plotted as straight lines, their intersection, the optimum point where the piston's impact and bottoming forces are equal, occurs at $F_I = F_B = 8700$ lb for a snubbing force of $F_S = 14{,}900$ lb. The value of $F_S = 14{,}900$ lb at $X_{2V} = 12$ in./sec. will give optimum snubber performance for the example system. The value of F_S is controlled by design of the proper size of restricting orifice according to equation (5). ▼▼▼

HOW TO CALCULATE DESIGN CONSTANTS

The designer may not have some of the design constants used in this technique. They may, however, be calculated quite easily. The effective servovalve orifice area A_1 may be calculated by assuming rated valve flow at rated valve pressure drop and applying the sharp-edge orifice equation $Q = kA_1\sqrt{\Delta P}$ where $k = 110$.

This same equation may be used to size the snubbing orifice, A_o.

The structural spring rate K may be calculated if the load mass and natural frequency are known, by applying the equation $K = M\omega^2$.

where K = structural spring rate (lb/in)
M = load mass = slugs/12
ω = load natural frequency (radians/sec.)

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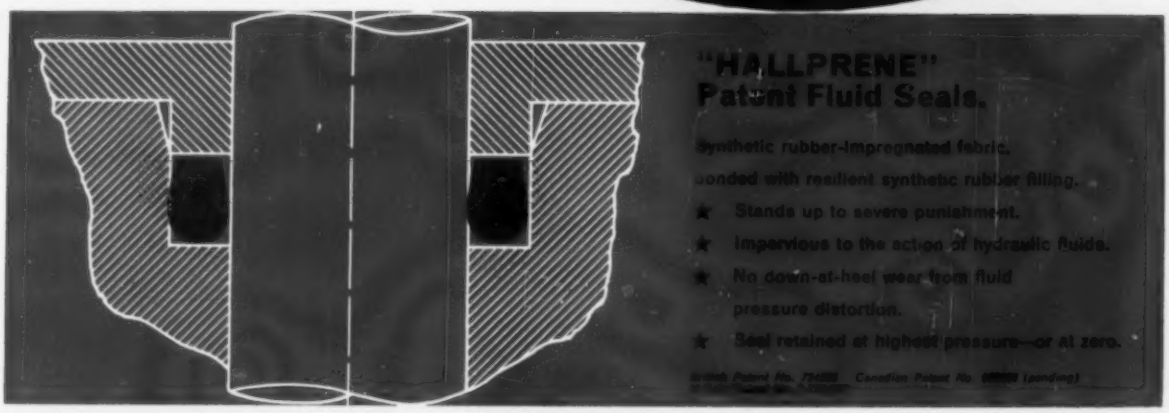

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British Patent No. 724033 Canadian Patent No. 608008 (pending)

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- ★ Simplifies piston design.
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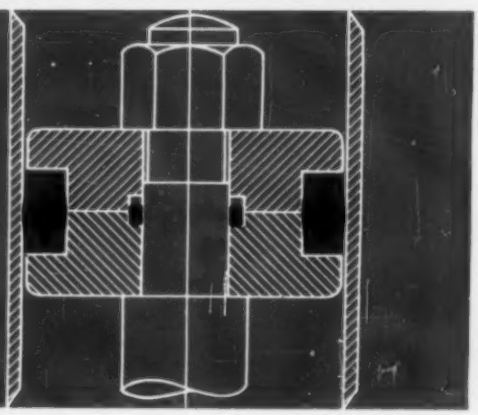
British Final Patent No. 857,248 French Patent No. 1241572 U.S.A. Patent No. 3131
Patents Applied for in other Commonwealth and European Countries.



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New tests for measuring aerospace hydraulic contamination

• By **JEFF HALL**, *Hydraulic Design Engineer General Dynamics/Astronautics, San Diego, Calif.*

At the August meeting of the American Society for Testing Materials, the Aerospace Test Methods Section presented new test methods for identifying and measuring particulate, fibrous, gelatinous, radiological, and biological contamination.

MANY new hydraulic fluid test methods were presented for measuring contamination and determining fluid properties during the three-day meeting last August at the Pacific Palisades of ASTM's Section I on test methods for aerospace hydraulic fluids.

The high spot of the meeting was the paper and color photomicrographs presented by Paul H. Dutch, Senior Chemist of Atomics International, on propsed test procedures for identifying eight metallic and six fibrous contaminants in hydraulic fluids (iron, copper, silver, aluminum, chromium, magnesium, nickel, and molybdenum; cotton, Orlon, Dacron, nylon, rayon, and wool.) The procedures are applicable to individual metallic particles using both microscopic and spot test techniques. Fibres are identified by specific identification stains. The techniques will identify most common metals and alloys, their corrosion products, and common fibers. Modifications or extensions of these techniques could be made for identification of other minerals, paint chips, and rubber. The tests were developed under an Air Force contract, and are described in two reports published by the Armed Services Technical Information Agency.

• **New Laboratory Tests**—Contamination Committee Chairman Wally Zittle of Martin reported that two test methods had been produced for particulate contamination determination: one, gravimetric, and the other, microscopic. The gravimetric method was prepared by A. D. Rottler and P. D. Michaelson of Boeing's Aerospace Division. The total particulate contamination, including both organic and inorganic material, is determined by passing a given quantity of sample fluid through a membrane filter disc, and measuring the increased weight of the filter. In addition, the disc is microscopically scanned for excessively large particles, fibers, or other unusual conditions. Its accuracy is +0.05 mg/100 ml of sample fluid. This is compatible with the contamination levels of even the relatively clean fluids in aerospace applications. A round robin series of tests will be run to get experience with the method.

The proposed microscopic method was presented by Mr. Zittle. Here also particles from a given quantity of the fluid are trapped on the surface of a membrane. Then the particles are examined, sized, and statistically counted by microscopic means using the globe and circle reticle or area-sizing and square-root-of-2 progression technique. Prior to each sample analysis, a blank analysis is run to determine the amount of non-sample contamination being introduced by the sample bottle, filtering process, filtering equipment, filter disc, and the petroleum ether. When reporting a particle analysis, the blank analysis must also be reported.

• **Use Care In Taking Samples**—Fred W. Cole, Staff Engineer of Bendix Filter Division, as chairman of the Sampling Methods subcommittee, surveyed the problems associated with contamination sampling methods in hydraulic systems. A valid fluid sample must be used for analysis. If the sample is not truly representative of the contamination in the

Continued on page 130

ASTM Activities in Hydraulic Fluids

Creating and standardizing test methods is the responsibility of the American Society for Testing Materials which was formed in 1902. Technical Committee N (Tech N) on Hydraulic Fluids, formed in 1955 under Committee D-2 on Petroleum Products and Lubricants, has ten sections.

Section I on Aerospace Applications for Hydraulic Fluids Test Methods, formed at the same time as Tech N, is concerned exclusively with providing test methods for aerospace hydraulic fluids. The names of some of the Section's sub-sections and sub-committees outline its work areas: Simulative and Nonsimulative, Compatibility, Sequential Immersion Methods, and Recirculating and Non-recirculating Systems. The largest by far is the Contamination Determination Committee with the following subcommittees: Definitions, Sampling, Microscopic, Gravimetric, Field and Factory, Gels, Radiation, Biological, and Identification.

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NEW TESTS

system being measured, no absolute or independently reproducible information can be determined. Early sampling practice has proven to be partially successfully from a practical standpoint, but lacking in accuracy. It consisted of drawing off the fluid sample through a conveniently placed tee or similar fitting in the hydraulic line without regard to fluid flow geometry or other factors. However, the tee may cause the sample to have a contamination distribution different from the main stream. Most special sampling fittings have been designed with an internal probe which projects into the fluid stream in order to extract a valid sample. However, if the fluid velocity in the probe is higher than the velocity of the stream, the sample will tend to contain a larger proportion of small particles. Conversely, if the fluid velocity in the probe is lower, the sample will contain a disproportion of large particles. These inertial effects may be overcome with isokinetic sampling probes, in which the velocity in the probe and stream are adjusted to be equal. Both isokinetic and turbulent flow sampling will be investigated.

• **Who Develops Contamination Standards?**—ASTM Section I establishes test methods only. Establishing contamination standards of cleanliness for system evaluation will be left up to other associations or professional societies such as AIA and SAE. However, there are differences in the particle size ranges between ASTM, SAE, and the AIA's report number ARTC-28. To better resolve those differences, the meeting passed a resolution requesting the reactivation of the AIA committee which originally produced ARTC-28.

• **New Simplified Procedures**—The first drafts of three proposed field and factory methods for particle contamination determination were presented by Chairman Joe Botkin, Lockheed Missiles and Space Co., who said the proposed methods are in need of additional work. They were presented for study by members. Because each method is a monitoring or quality control procedure for judging whether or not the particle contamination level of the fluid is within acceptable limits, they are relatively cursory methods. Procedures are simple, only a small amount of test apparatus is required, and personnel need only slight training.

The most simple test is a visual go, no-go limits comparison field method. A membrane filter disc is visually inspected under a minimum of 8X magnification with $1\frac{3}{8}$ in. diameter field and compared to limit standards. No provisions are made for particle counting.

The second, is a visual limited sizing and counting method. Particles trapped on the surface of a membrane filter disc are inspected under a minimum of 10X magnification, with $1\frac{3}{8}$ in. diameter field, and are compared to a simplified globe and circle reticle. It is suitable for field use because of its simplicity, and the portability of the one-piece of apparatus.

The third test method is a visual sizing, counting, and identification method suitable for factory use because of the simple procedures and portability of the test apparatus. A membrane filter disc is inspected under a minimum of 10X with a $1\frac{3}{8}$ in. diameter field and 20X with a field of 11/16 in. diameter, and is compared to a globe and circle reticle which also has linear scale.

• **Watch for Biological Contamination**—Little or no evidence of microbe or fungus contamination has been reported in hydrocarbon hydraulic fluids. However, Bob Kunkle, Lockheed Aircraft, said that knowing about biological contamination in fuels might alert hydraulic engineers to observe more closely for such contamination in hydraulic fluids. Microbial slime growths in airplane fuel tanks corrode the tanks and clog the fuel system filters and valves. In a tank, bacteria and fungi feed and multiply at the interface between the fuel and free water. (Free water may occur in hydraulic systems when the dissolved water exceeds 150-200 ppm.) Bacteria have been grown by one company at the interface between free water and peroleum base hydraulic fluid.

Frank E. Swatek, Head of the

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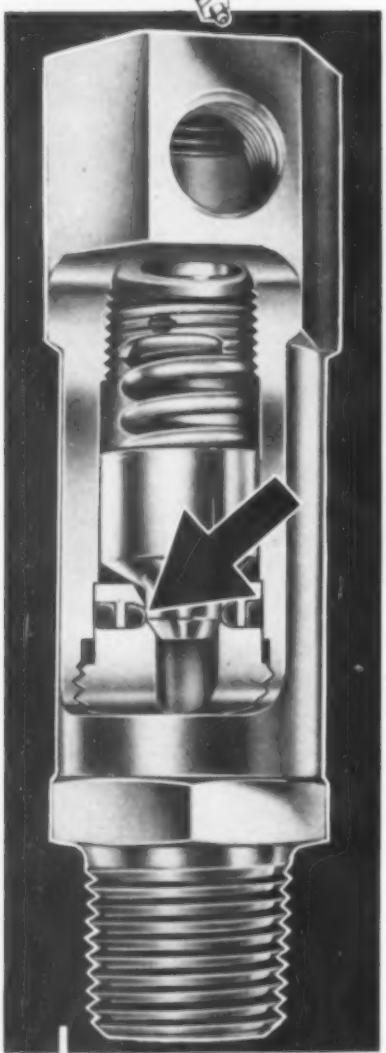

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NEW TESTS

Department of Microbiology, Long Beach State College in California, said water is necessary for growth to begin. Only a small amount is necessary because once growth starts the organisms generate their own water from hydrocarbon decomposition. The energy requirements for metabolism are supplied by oxidation of the carbon chains from the fuel by the organism. Mineral salts, certain elements (Ca, P, Mg), and a specific concentration of carbon dioxide are necessary for reproduction.

- **Definitions**—Proposed nomenclature and definitions for contamination analysis and control was presented by Jess I. Black of North American's Autonetics Division. The definitions will provide a common semantic basis for communication in order to improve analytical methods and techniques.
- **Gel contamination**—Results from a questionnaire on gels in hydraulic fluids and systems sent out by the Gels Determination Methods subcommittee were reported. Steve Kovscich, California Research Corp., said there was only a 10% return of questionnaires. About half of those reportting found some problems associated with gels. The definition of gel (a macroscopic solid or semisolid network which may contain a high percentage of fluid within its structure) was found to be inadequate. It was referred to the definitions subcommittee for further study.

Other Section I news:

Radiation Contamination—Norm Parrish, Lockheed Missiles and Space Co., reported that there is much data accumulated, but it has not been investigated as to how to determine contamination.

Non-Simulative Testing—Joe Botkin stated that many ASTM methods for tests of specific fluid parameters are available. A list of these methods was circulated. New methods will be developed as required by the non-simulative committees.

Safe Handling—Discussion by members indicated that no action should be taken at this time because other societies have more jurisdiction in this area.

Hydraulic Fluid Elastomer Compatibility—J. W. Wechseberger of Plastic & Rubber Products Co. discussed sequential testing of fluoro-silicone and fluoro-carbon other elastomer seals in various proprietary fluids. J. B. Johnson of Linear Incorporated is chairman of this subcommittee.

Simulative Testing—Mr. W. Galloway (alternate for E. A. Webster, Douglas Aircraft Testing Division), reported that this committee is developing standard schematics *and* data sheets for use with the dynamic system test method for evaluating servospace hydraulic fluids. ▼▼▼

How testing methods Increase reliability

• By **JOE BOTKIN**, *Lockheed Missiles & Space Co., Burbank, Calif. Chairman, ASTM Section I, Aerospace Applications*

Reliability and test methods go together like love and marriage. However, reliability is a big subject, so let's take aerospace hydraulic fluids and see how reliability and test methods work together.

Reliability describes the ability of an item to function as intended. An item is determined to be reliable, beyond doubt, only by actual or simulated use. Test methods, along with other functions, are used to monitor actual use, to simulate use, to monitor simulated use, and to establish a norm.

Continued on page 134

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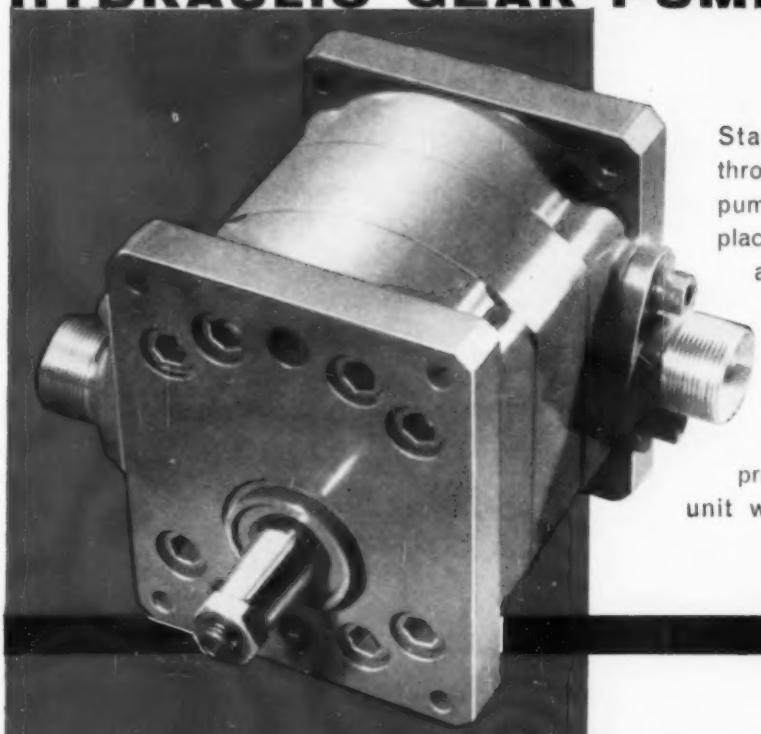

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TYPE	Maximum Continuous Pressure	G.P.M. at 1000 r.p.m.	Cu. In. per Rev.	Maximum Speed
GP.2004A	2,000 p.s.i.	4.3	1.19	3,000 r.p.m.
GP.2005A	2,000 p.s.i.	5.8	1.63	3,000 r.p.m.
GP.1707A	1,700 p.s.i.	7.3	2.02	3,000 r.p.m.
GP.1209A	1,250 p.s.i.	9.4	2.6	3,000 r.p.m.
GP.3011	3,000 p.s.i.	11	3.0	2,000 r.p.m.
GP.2011	2,000 p.s.i.	11	3.0	2,000 r.p.m.
GP.2017	2,000 p.s.i.	17	4.6	2,000 r.p.m.
GP.1522	1,500 p.s.i.	22	6.1	2,000 r.p.m.
GP.1033	1,000 p.s.i.	33	9.1	2,000 r.p.m.

For full details write to

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Keelavite Hydraulics, Ltd.,
Pieter de Hoochstraat 17
Rotterdam 6, Holland

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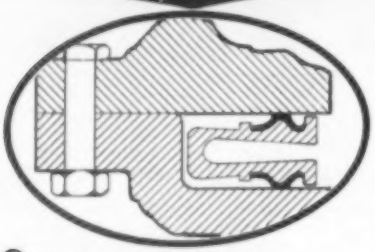
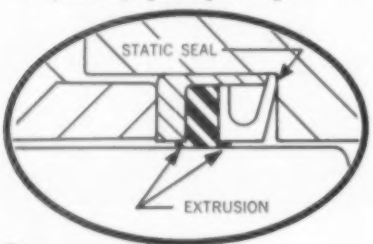
FOR UNIQUE OR CRITICAL SEAL PROBLEMS



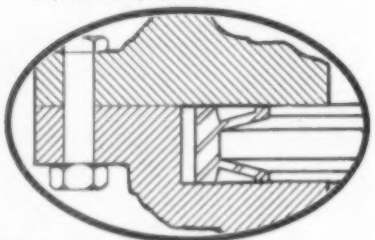
1 DEL PNEUFLEX STATIC SEALS

- Designed specifically to meet cryogenic applications of low and high pressure requirements in missiles and high performance aircraft.
- A flexible metallic ring with protruding Teflon sealing edges. Uses inherent spring property of the metal ring and the pressure being sealed to force a tight joint.
- Temperature range from —450°F to 500°F at pressures up to 5000 PSI. Re-usable. Requires only light flange loading.



2 DEL SHAFT SEALS

- For reciprocating or low speed rotary motion.
- Only spring-loaded Teflon seal using extrusion principle.
- Guarantees leak-proof fit, controls cold flow . . . is self-compensating for wear.
- Temperature range of —320°F to 500°F at pressures up to 10,000 PSI.



3 HASKEL METALLIC FACE STATIC SEALS

- Silverplated Inconel-X seals.
- Designed specifically for extreme temperature requirements of systems in missiles and high performance aircraft.
- Integral height control. Install by indexing seal to one mating surface and bringing opposite surface against seal.
- Temperature range from —450°F to 2000°F at pressures up to 20,000 PSI. Re-usable. Requires only light flange loading.

For complete information, contact

HASKEL SEALS A DIVISION OF

Haskel ENGINEERING & SUPPLY CO

1236 So. Central Avenue, Glendale 4, California

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TESTING METHODS

Tests improve reliability in three ways:

- Hydraulic fluid development depends upon tests to determine its characteristics.
- Production tests insure that the product is within acceptance limits.
- Hydraulic fluid in service is monitored by tests, to insure the reliability of the hydraulic system.

• What Is Section I Doing?—The initial stage of this comprehensive program calls for creating and standardizing an integrated *family* of the most needed test methods for service in the development, manufacture, and use of aerospace hydraulic fluids. A family of 24 related test methods is being developed *simultaneously* because:

> The methods are needed now. If we produce one or two at a time, the program would take from 10 to 20 years. Simultaneous development will complete the program in as many months.
>
> One method or a half dozen methods will not supply the needs or really solve the problems associated with aerospace hydraulic fluids. The belief that a few methods will do so leads to over confidence and then to confusion when they fail. It takes the complete family of related methods to solve the problems.
>
> To be of any real use, these 24 methods must not conflict, but must be correlated. It must be possible to choose a number of test methods that will apply to a single problem. For example, sample taking, sample processing, and the analysis or determination may require three test methods used as one *procedure* in order to resolve a problem. Only if all the methods are developed together are they really likely to be a family and of value.

These methods must be readily used and understood by the persons who perform the test. Of equal importance, the readout or findings must be meaningful and readily understood by the persons who act on the test findings. We aim to be practical always, and not overly scientific.

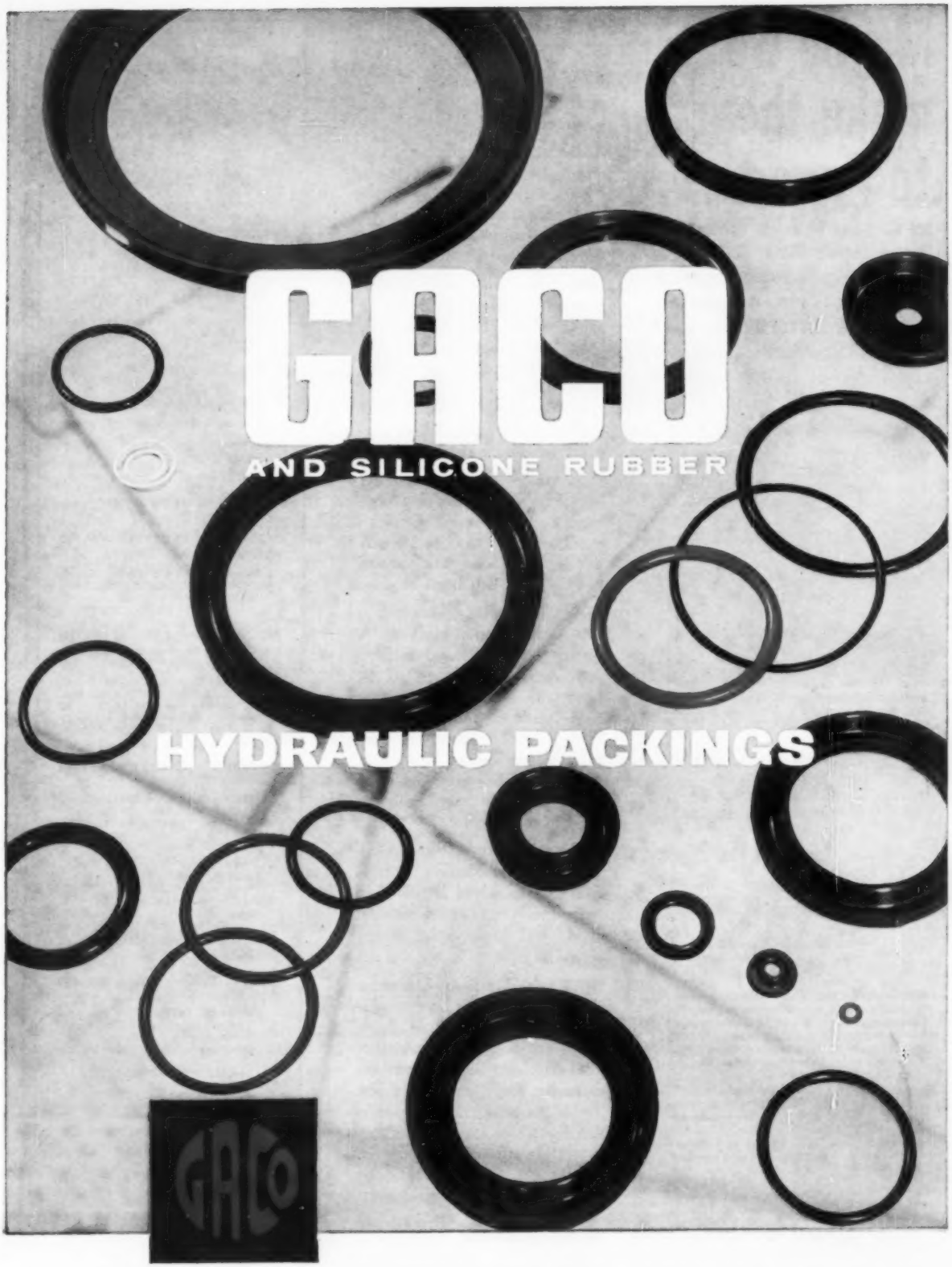
• Issuing Test Methods—After a test method is created, it is issued for trial and comments and for interim use by Section I. It is not an official ASTM method. When Section I is satisfied that the method is the best that can be had at the time, it is submitted for official approval and adoption by ASTM.

Test Methods Ready for Trial or Interim Use

1. Recirculating Dynamic System Test Method. Useful for learning a new hydraulic fluid is characteristics, and obtaining information for system design.
2. Monitoring and Quality Control Testing. Several existing ASTM laboratory test methods are suitable for aerospace hydraulic fluids These are tests for viscosity, specific gravity, water content, acid number, flash point, index of refraction, etc.
3. Microscopic Method for Sizing and Counting Particulate Contaminants. This method sizes the particle by comparison to a circular area (globe and circle reticle). It correlates very well with automatic counters and to less sophisticated field and factory visual methods. The square-root-of-2 counting technique together with the above sizing system promise increased accuracy, better agreement between operators, and a faster, easier procedure.
4. Proposed Method for the Determination of Particulate Contamination of Hydraulic Fluids by Gravimetric Analysis. This is a revised version of Boeing's gravimetric method. It is extremely useful for determining the quantity of contaminants which cannot be readily counted.

Test Methods in Process

1. Fluid Sampling Methods. Will include sampling from containers, components, and systems. Sampling techniques and requirements are being investigated.
2. Airborne Sampling Methods. Methods using impingement, bubbler, and filter disc sampling may be required. The membrane filter disc method is in process at this time.
3. Gel Contamination Determination Methods. Several methods may be required to determine the various gels and the dif-



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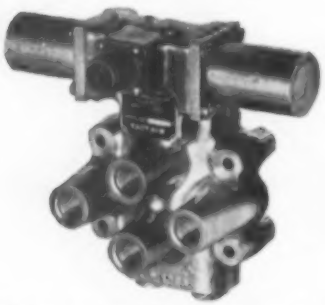

SPECIAL: 4-Way Pneumatic Valve, Solenoid Operated. A 4-way, 3-position, solenoid-operated pneumatic directional control valve. Pilot-operated main valve provides high flow, rapid actuation, low current drain, light weight. Series 9801.

STANDARD: 3-Way Selector Valves. Solenoid-operated, hydraulic selector valves designed with fully balanced inverse poppet for a wide range of flows and pressures in either direction without affecting operating characteristics. Series 6000.

Now where on earth . . . or in outer space . . . can you use the precision of TACTAIR valves? As a starter, let us send you more details on our products and capabilities. Write TACTAIR Valve Division, Aircraft Products Company, Bridgeport, Penna.

CONTROL, SELECT, BRAKE, RESTRICT, CHECK . . . with

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TESTING METHODS

ferent areas where gels are a problem. Outline methods are in process.

4. Radiation Contamination Determination Methods. Methods for reactor and space radiation determinations are required. An investigative program has been started.
5. Biological Contamination Determination Methods. Methods are required for determining whether biologicals, such as bacteria and fungi, are present in the fluid, or if biologicals can exist in the fluid. A data collection and methodology program is under way.
6. Contamination Identification Methods. For identifying contaminants by visual, chemical, and physical determinations. A method has been written and has been presented.
7. Field and Factory Contamination Determination Methods. A visual go, no-go field method has been outlined and is in process. A more comprehensive field method and a factory method are in process. They provide for limited sizing and counting. The first draft of these methods have been issued for comment.
8. Non-Recirculating (Blowdown) Dynamic Test Method. This is a fast method and is useful in the development of hydraulic fluid, and for system design data. It is in process.
9. Sequential Fluids to Elastomer Test Method. This method duplicates the actual and probable sequence of immersions of the elastomer seal in various hyraulic fluids, or grease and fluids, as could occur in service. Elastomer seals may be very adversely affected by sequential immersion even though the fluids are of the same family. An investigative test program has been started.

This gives you a general idea of the scope of the present Section I program aimed at improving the reliability of aerospace hydraulic fluids. ▼▼▼

PUBLICATIONS

HOW TO SELECT QUICK-CONNECT COUPLINGS . . . Nov., 1960

8 pages discussing the design factors which a user should consider in selecting a coupling. Sectional drawings of various designs.

WHAT YOU CAN GET IN ROTARY ACTUATORS . . . Aug., 1960

8 pages showing designs, operating specifications, and application ideas.

PLASTIC LINES—CAN THEY MEET YOUR FLUID POWER NEEDS? . . . Apr., 1960

This report boils down the characteristics of various types of plastic tubing—the 'do's" and "dont's" for successful applications.

WHAT TO LOOK FOR IN AIR VALVES . . . Apr., 1959

16 pages describing and illustrating basic designs of directional, pressure, and flow control valves.

TEMPERATURE CONTROL IN HYDRAULIC SYSTEMS

16-page report on system design, fluids, packings. Components affecting temperature control.

A COURSE IN HYDRAULIC VALVES
PART 1: Directional Controls

Basic characteristics of spool, packed plunger, rotary, poppet, sliding plate valves.

A COURSE IN HYDRAULIC VALVES
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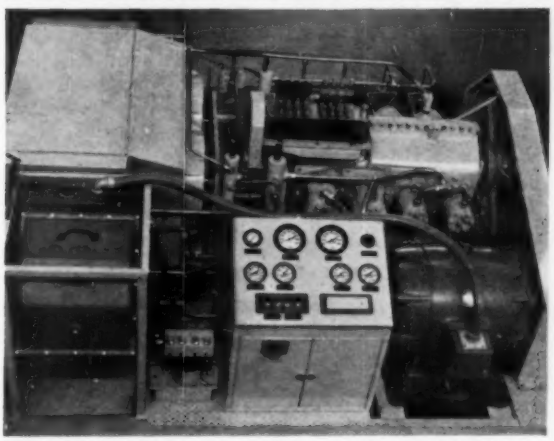

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Very low back pressure. Disc sealing on "O" ring seat—3,000 PSI service. 1 PSI crack pressure. Leakproof.

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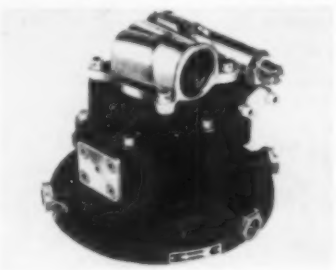
Airborne Hydraulic Pump

Features: Hydraulic pump in a small envelope for aircraft and missiles is single-stage, variable-volume, cam-actuated with pressure compensator control. All rotating parts are hydraulically balanced. Pump does not require a universal drive nor anti-friction thrust bearings. Top performance is maintained with up to 40-micron contamination.

Specifications: Delivers 10 gpm at 6000 rpm and 3000 psi, with maximum displacement of 0.40 cu. in./



rev. Weight is 6.5 lb. Volumetric efficiency is over 95% through pressures to 3000 psi. Response characteristics meet and exceed those required by MIL-P-25868 and MIL-P-19629.

Designation: AP2V.—*Kellogg Div., American Brake Shoe Co., New York.*

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Light Air Bleed Valve

Features: Small, rugged valve for bleeding air from aircraft and missle hydraulic lines, even when the system is under maximum pressure. The valve can be installed in closed fluid systems, actuators, or reservoirs; remotely positioned, or at extreme high points. Stainless steel, precision machined body has rolled body edges. Meets MIL-H-8775 for a Type 3 system. "Bleed Valve Test Report (RD112-44)" is available.

Specifications: For pressures to 3000 psi at temperatures from −65 F to 500 F.—*The Weatherhead Company, Special Products Div., Cleveland.*

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Metal Hydraulic Seal

Features: Dynamic hydraulic seal of high temperature, alloy steel has performed satisfactorily at temperatures to 530 F and pressures to 6000 psi. Does not require close tolerances, is self-compensating for reasonable misalignment and side loads, and requires extremely low break-out force. It has been tested with reciprocating and rotary motions and is also available for static applications. Uses the principle of a blunt knife edge with controllable unit load. Seals pressures while holding the load on the radial edge of the seal low, keeping the break-out force low.—*B. F. Goodrich Aviation Products, Troy, Ohio.*

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Quick Disconnect Couplings

Features: For hydraulic, fuel, oil, gases, and other fluid systems. Push-to-engage and pull-to-disengage. Each of the three series have common bodies for each flow size with interchangeable end fittings.

Designation: Series A, the premium series for aircraft, missile, and other applications requiring extreme re-

Continued on page 140

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FD® FLUID DYNAMICS INCORPORATED
Dept. HP-11, 90 West St., New York 6, N.Y.

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CIRCLE SEAL GAUGE PROTECTOR

SERIES 1100

A safety shield for gauges and personnel, the Circle Seal Gauge Protector is designed for pneumatic or other gas systems as well as liquid service. Use of contact rather than sliding seals overcomes O-Ring breakaway friction problems associated with piston type units. Automatic cut-out when system pressure exceeds gauge limit... automatic cut-in when system pressure returns to normal maximum. In gas systems, surge or shock waves will close valve momentarily to reduce shock to gauge elements. Where gauges are cascaded, Gauge Protector automatically cuts out lower pressure gauges... cuts them in as system pressure falls.

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From 15 to 2400 psi... —100° to 500°F. Wide range of cut-out pressure settings. Available in brass or 303 stainless.

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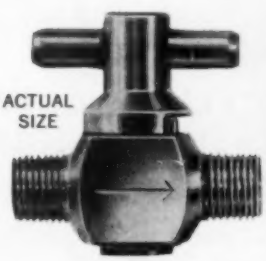

SERIES 9500

CIRCLE SEAL MINIATURE PLUG VALVE

Miniaturized at no sacrifice in quality, the Circle Seal 9500 Series is ideal for application in instrumentation, inert gas test stands, hydraulic clamps, jacks, etc. The convenient "T" handle with 90° actuation provides effortless opening and closing. The handle is color coded for various gases and liquid service requirements. The visual indication provided by the "T" handle can be used as a metering device by turning the handle various degrees from full-on to full-off. "O"-Ring seals virtually eliminate wear. When required, simple repair is effected by replacing three "O"-Rings without removing valve from the line.

ABSOLUTELY LEAKPROOF ... EFFORTLESS CONTROL

Positive sealing from high vacuum to 2000 psi. Male or female connections in ⅛" or ¼" sizes. Brass or 303 stainless.

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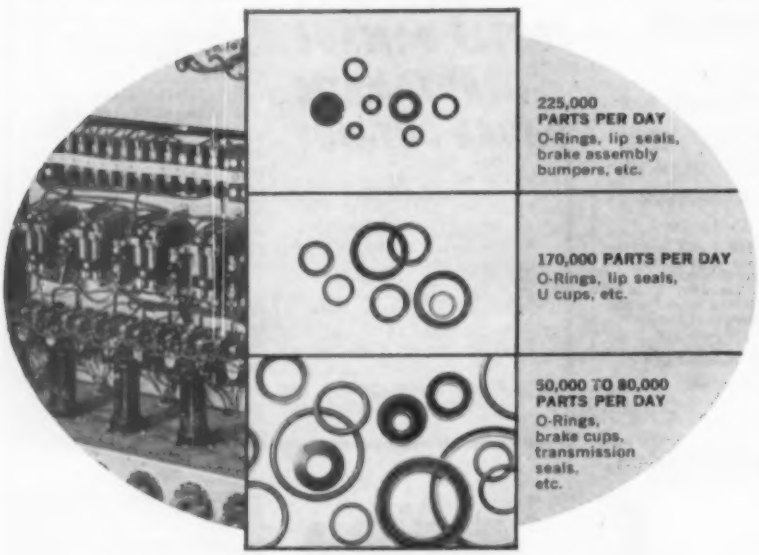
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PARTS PER DAY
O-Rings, lip seals, brake assembly bumpers, etc.
170,000 PARTS PER DAY
O-Rings, lip seals, U cups, etc.
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PARTS PER DAY
O-Rings, brake cups, transmission seals, etc.

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AEROSPACE COMPONENT DATA

liability and precise operating performance. Series *C*, for industrial and commercial applications. Series *E*, for electronic cooling systems. *—Exeter Connectors, Inc., Exeter, New Hampshire.*

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Temperature Compensating Coupling

Features: Used to join and seal pipes, lines, and tubing subjected to severe servicing conditions in aircraft and missile applications. Provides leakproof joints in lines carrying helium, argon, oxygen, and liquid sodium. The coupling consists of a high-strength, high nickel alloy band. Fingers at intervals along the edges of the band are curved over stainless steel inserts or expanders. The different coefficients of expansion between the band and the inserts makes the coupling temperature compensating. At any given temperature, coupling pressure on the flange is never below the installed tension. Couplings are installed by tightening one T-bolt.

Specifications: Available in sizes from 1-in. to 40-in. ID. Have been subjected to operational temperatures from −320 to 1750 F, pressures to 8000 psi, and vacuums to 0.8 microns.*—D.S.D. Manufacturing Co., Hamden, Conn.*

Circle **504** on Reader Service Card

Metering & Shutoff Valve

Features: Newly modified valve has zero leakage at 0.02 micron absolute pressure. The valve was tested with helium and a mass spectrometer leak detector having a sensitivity of one part helium in 300,000 parts air. This means that any leak is less than 10 cc of helium per year. Copies of the test report are available.

Specifications: T180 three port, INS instrument type, standard design.

Designation: 375, 414, and 427 series*—Robbins Aviation, Inc., Los Angeles, Calif.*

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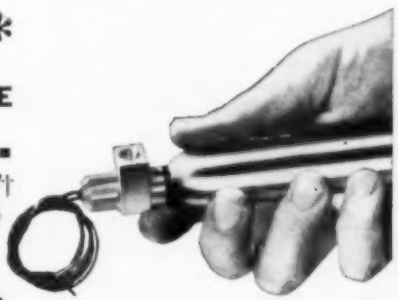
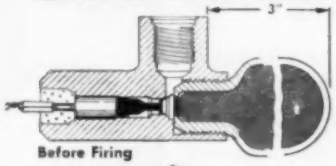
conax

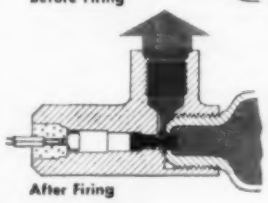


A hermetically sealed nitrogen-filled cylinder controlled by a CONAX explosive-actuated valve . . . operates with 2 amps., to actuate valves or pneumatic actuators, and pressurize or purge system.

For complete information write for catalog 361-XV



Before Firing



After Firing

conax *CORPORATION*

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* Up to 3000 psi available on request

† Explosive-Actuated Gas Energy Release Packages

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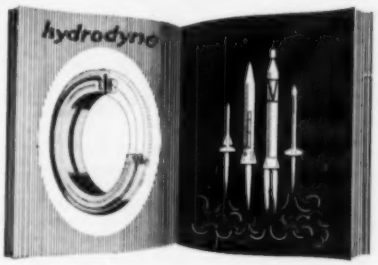
static spring

SEALS

Are No. 1 in Any Engineer's Book



Sealing problems multiply for missile men as they probe further into the realm of extreme pressures and temperatures encountered at aero-space frontiers. By solving these critical problems in missile, aircraft, and nuclear applications, Hydrodyne is helping to write new chapters in the annals of advancing technology. Skinner High Temperature Seals produced by Hydrodyne answer the need for a seal that functions reliably in temperature extremes from —420° to +2000°F. Precision-machined from nickel alloys and other temperature-resistant materials, these seals are designed for best distribution of stresses in a given application and environment.

- For fuel pumps, compressor units, turbine starters
- With reactive or contaminating fluids and gases
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some footnotes

MACHINED BELLOWS

Proven precision machining process (weld-free) assures absolute structural integrity, eliminates failures from metal fatigue through as many as 1,000,000 cycles. Controlled-wall-thickness technique concentrates strength at stress points. Machined bellows are custom designed in lightweight alloys and materials resistant to environmental extremes.

ROTARY FACE SEAL

All-metal bellows of steel or nickel alloys; sealing faces and mating rings of carbons, alloys, ceramics, other materials for specific environments: Temperatures, —400° to +1200° F; pressures, 0 to 10,000 psi; speeds to 60,000 rpm.

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Subsidiary of Donaldson Company, Inc.

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Gauges

The right gauge for your specific needs

A complete line of gauges in stock available for early delivery. Gauges from 10-inches water pressure to 30,000 P.S.I. to meet your specifications on any equipment.

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S.A.E. straight thread tube fittings

Form the standard, internal o-ring boss and port contour for the new straight thread tube fittings recently introduced by major fitting manufacturers to replace taper pipe ports.

- forms complete contour in one pass
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- high speed steel, form relieved for easy reconditioning
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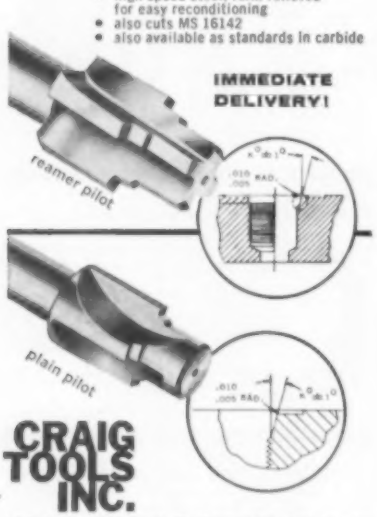

CRAIG TOOLS INC.
133 Lomita Street, El Segundo, California

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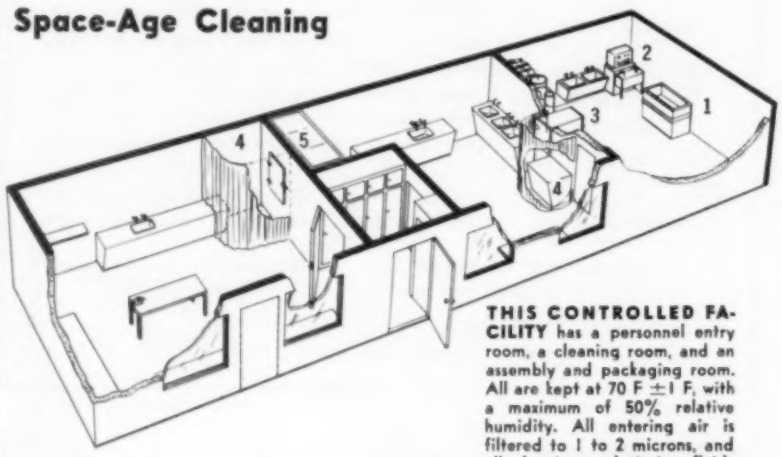
AEROSPACE NEWS

from the fluid power field

Space-Age Cleaning



THIS CONTROLLED FACILITY has a personnel entry room, a cleaning room, and an assembly and packaging room. All are kept at 70 F ±1 F, with a maximum of 50% relative humidity. All entering air is filtered to 1 to 2 microns, and all cleaning and rinsing fluids are cleaned by twice passing through 10-micron filters. The entire area is pressurized so air flows out of any openings. (1), vapor de-greaser. (2), ultrasonic cleaning. (3), entry pass-through. (4), ultra-violet light. (5), vacuum dehydrator pass-through.

To produce super-clean aerospace components Republic Manufacturing, Cleveland, recently completed an environmental-controlled facility. This white room is used for pre-cleaning, cleaning, assembly, and packaging of components for hydraulic, air, liquid oxygen, fuel, and other fluids. The facility is under constant microscopic sampling control.

Ultra-violet begins the process of super-cleaning, after ultrasonic cleaning and vapor de-greasing. This check is frequently repeated. Parts are rewashed in cleaning so-

THIS HYDRAULIC TEST ROOM is another contamination-controlled area. A separate room is necessary because hydraulic oil must not enter the cleaning and assembly area.

lution then rinsed in de-mineralized water, followed by an alcohol bath. They are immediately placed in the vacuum dehydrator pass-through to the assembly room.

ULTRASONIC CLEANING of parts occurs after vapor bath de-greasing which is the first step. The cleaning processes are progressively refined as parts move through the system.

In the assembly room parts are again examined under ultra-violet light. Approved parts are assembled and assemblies are tested. Then units are heat sealed in double polyethylene bags before they leave the assembly room.

All service items such as filters, air conditioners, de-mineralizers, gas supplies, and vacuum cleaning equipment are kept outside the controlled areas.

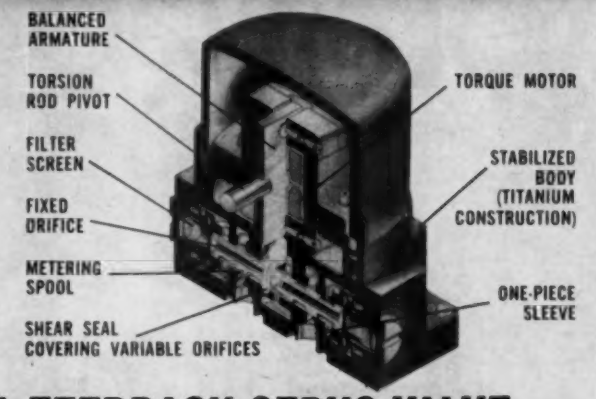
Glass filament bottles pressurize Mercury and Redstone vehicles

Filament-wound, fibre-glass, pressure bottles designed and produced by Apex Reinforced Fibre-Glass, a division of White Sewing Machine, Cleveland, are integral parts of the propulsion systems of the Mercury spacecraft and its Redstone booster.

In the Mercury, two bottles provide pressure in the fuel system to the 18 rocket motors (rated from 1 to 24-lb thrust) which control the attitude of the vehicle in flight. The bottles, pressurized with nitrogen to 2200 psi, propel hydrogen peroxide to the motors. One bottle is a pressure source for the 12 reaction motors in the capsule's automatic orientation system. The second bottle pressurizes the 6 motors which are manually actuated by the astronaut.

Mercury bottles are about 8 in. in diameter with a 250 cu. in.

Continued on next page



A FEEDBACK SERVO VALVE WITHOUT SPRINGS OR LEVERS

- Unity coupled Hydromechanical Feedback
- High Null Accuracy
- Only 2 moving parts
- Large, full opening, shear-seal orifices

This two-stage, four-way flow control valve is the only one available that provides true positional feedback without springs or levers. The first stage consists of an electrical torque motor and "shear-seal" orifice hydraulic amplifier, while the second or control stage is made up of an accurately matched spool and sleeve arrangement.

Hydromechanical unity feedback relates spool position to torque motor armature position and also nulls out effects of orifice variations due to supply pressure and temperature fluctuations. Flow force reactions are thus substantially reduced and hydraulic centering of pilot position is feasible without spring hysteresis and null shift. Large orifices prevent clogging and silting and high shear forces permit efficient operation even with highly contaminated fluids. Final null adjustments are made electrically by a balancing control at amplifier output stage.

TYPICAL CHARACTERISTICS

	Medium Flow (#6103-#6106)	High Flow (#6104)
Rated flow	to 7.5 gpm at 3000 psi valve pressure drop	to 18.0 gpm at 3000 psi valve pressure drop
Hysteresis	3% maximum total rated current	3% maximum total rated current
Supply pressure	300 to 3000 psi	300 to 4000 psi
Proof pressure	4500 psi pressure port 3000 psi return port	6000 psi pressure port 3000 psi return port
Pressure gain	First stage—500 psi per ma minimum with 3000 psi supply	First stage—500 psi per ma minimum with 3000 psi supply
Load pressure gain	8500 psi per ma minimum with 3000 psi supply	10,000 psi per ma minimum with 3000 psi supply
Temperature	—65°F to +275°F	—65°F to +275°F
Maximum Null Shift	(% of rated current)	
Temperature Change per 100°F	1%	1%
Supply Pressure Variation ±	2%	2%
Quiescent Current Change 20%	1%	1%
Weight	12 ounces	16 ounces

TORQUE MOTOR: Note: 6103 & 6106 identical with exception of torque motor characteristics.

	Valve #6103	Valve #6106
Input Power	300 Milliwatts	64 Milliwatts
Rated Current	± 10 ma	± 8 ma
DC Coil Resistance (other motors also available)	3000 ohms/coil	1000 ohms/coil

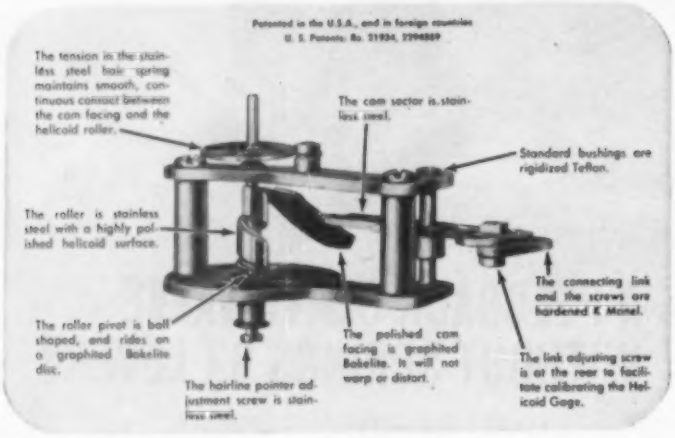
Write for complete data

KEARFOTT DIVISION
GENERAL PRECISION, INC.

Little Falls, New Jersey

Circle **86** on Reader Service Card

ACCO Helicoid Gage U.S.A.


Patented in the U.S.A., and in foreign countries
U. S. Patents: Re. 21934, 2294889
The tension in the stainless steel hair spring maintains smooth, continuous contact between the cam facing and the helicoid roller.
The cam sector is stainless steel.
Standard bushings are rigidized Teflon.
The roller is stainless steel with a highly polished helicoid surface.
The connecting link and the screws are hardened K Monel.
The roller pivot is ball shaped, and rides on a graphited Bakelite disc.
The polished cam facing is graphited Bakelite. It will not warp or distort.
The link adjusting screw is at the rear to facilitate calibrating the Helicoid Gage.
The hairline pointer adjustment screw is stainless steel.

Exclusive Helicoid movement provides... *Sustained Accuracy... on the toughest jobs*

• Helicoid Gages have no gears, no teeth, reducing wear to an absolute minimum. No danger of fouling, either—rolling action of cam facing keeps contact surface clean. Helicoid Gages have been tested through 75,000,000 cycles, with virtually no wear or loss of accuracy, while conventional geared gages became useless after 500,000 cycles.

Helicoid Gages give *sustained* accuracy even when subjected to violent pressure pulsations or mechanical vibrations. Pointer can be set externally, without removing glass, and cannot be jarred out of position. Dial faces are easy to read, won't corrode or chip. A full range of Helicoid Gages is available for any application. Next time, specify Helicoid—the gage that *stays* accurate.

Bourdon Tubes won't Stretch, Leak, or Crack

Helicoid Bourdon tubes are made from seamless tubing, and are designed for maximum torque and minimum stress. At the factory, each tube is individually tested, overpressured, and stress relieved. Four materials—alloy steel, K Monel, stainless steel, and phosphor bronze—are available to meet applications ranging from tap water to almost any acid.

NEW! Solid-Front Safety Case Gives Added Protection

The new Helicoid solid-front case diverts the force of a burst in a backward direction, away from the operator. The force escapes by deforming, though not detaching, the back cover plate. Helicoid Gages are also available in phenol, acaloy flanged, acaloy flangeless, polished flangeless, round flush, polished flush ring, and square flush cases.

WRITE for details

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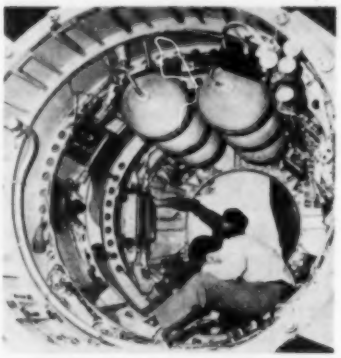
ACCO

Circle **75** on Reader Service Card

AEROSPACE NEWS

from the fluid power field

capacity, and have withstood burst tests in excess of 6000 psi. Fabricated by a process developed by Apex, the spheres are produced by winding a continuous fibre-glass filament impregnated with a thermo-setting resin around a hollow core. Fibre-glass has a favorable strength-to-weight ratio in comparison to titanium.



FILAMENT-WOUND FIBRE-GLASS PRESSURE BOTTLES in the tail section of the Redstone booster are filled with compressed air at 3000 psi, and are used to pressurize the booster's fuel system.

The Redstone booster uses six Apex bottles. They are mounted in the tail of the booster and pressurize tanks to assure constant fuel supply to the motors and to actuate main propellant valves. Redstone's bottles are 15 in. in diameter and contain about 1700 cu. in. of compressed air at 3000 psi. Pressure in the bottles drops to about 750 psi at the conclusion of the boosters propulsion sequence.

Filament-wound bottles produced by Apex are part of the Navy's all-fibre-glass Mark 32 torpedo launcher, and are in the combustion-starting system on the missile-armed USS Gyatt. They are also in the propulsion system of NASA's Saturn booster.

IMC Magnetics adds to staff

Raymond T. Pierson has joined IMC Magnetics, Marketing Division, Maywood, Calif., as a field engineer. He will service the missile and electronic industries in Los Angeles and Orange counties. ▼▼▼

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FJELLMAN VALVES
higher pressures at lower cost

Pressures:
6,000 p.s.i. 1½" to 3"
5,000 p.s.i. 3" and up

CHECK VALVES, PILOT-OPERATED CHECK VALVES, PRE-FILL VALVES, PILOT-OPERATED DUMP VALVES

VERY ATTRACTIVELY-PRICED: FJELLMAN high-pressure hydraulic valves are the finest anywhere — the end-result of 30-years experience in the high-pressure field. And, this engineering experience is readily available for any of your hydraulic problems. Write us.

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Available from Stock!
NEW, INEXPENSIVE, LIGHTWEIGHT ORDNANCE CRYOGENIC COUPLINGS from FUTURECRAFT

Patent Number 2971782

Now you can replace obsolete cryogenic couplings with these new screw type units from Futurecraft—and connect flex lines, tubing or pipe quickly, easily and *safely fluid-tight.*

These couplings—service proven on Ordnance projects—are pressure rated at 150 psi operating, 300 psi proof and 450 psi minimum burst. Only low torque is required for a safe, tight seal. These Futurecraft couplings are available from stock in sizes from 1" to 4" in ½" increments, LOX cleaned and packaged. Installation tools are available.

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AT TEMPERATURES FROM −400° F TO +1500° F!

ANY FLUID—GAS—FUELS—WATER—LIQUID METALS—CRYOGENIC FLUIDS—CORROSIVE FLUIDS
ANY SYSTEM—HYDRAULIC—PNEUMATIC—VACUUM—CRYOGENIC—NUCLEAR

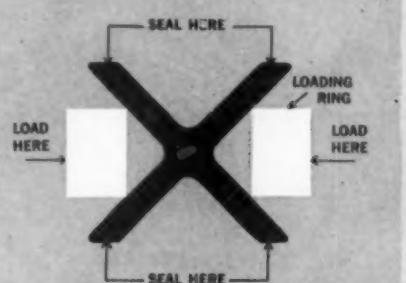
IT SEALS

HOT GAS SERVOS

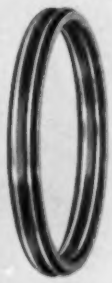
IT SEALS
?
YOURS

IT SEALS

VACUUM SYSTEMS

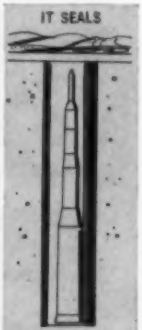


DUAL-SEAL REDUNDANT DESIGN
DYNAMIC & STATIC APPLICATIONS


BAR-X-SIZES:
½" TO 3" STANDARD
3" TO 12" SPECIAL

IT SEALS

SPACE ENVIRONMENTS

IT SEALS

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PUMPS

IT SEALS

HYDRAULIC ACTUATORS

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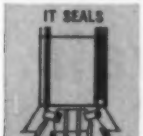
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UNPRECEDENTED SERVICE LIFE

Eliminates critical downtime ■ Very high and very low pressure ■ Easy, foolproof installation (not a mechanism) ■ All-metal—non-contaminating ■ Stable, symmetrical design

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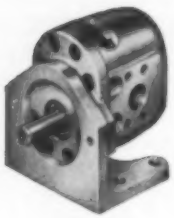
IT SEALS

NO DOWNTIME FROM SEAL FAILURE

IT SEALS

HIGH PRESSURES



SPEEDS TO 6000 RPM

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*Manufactured by Berry Hydraulics under license from Dowty Corporation for Bellows-Valvair.

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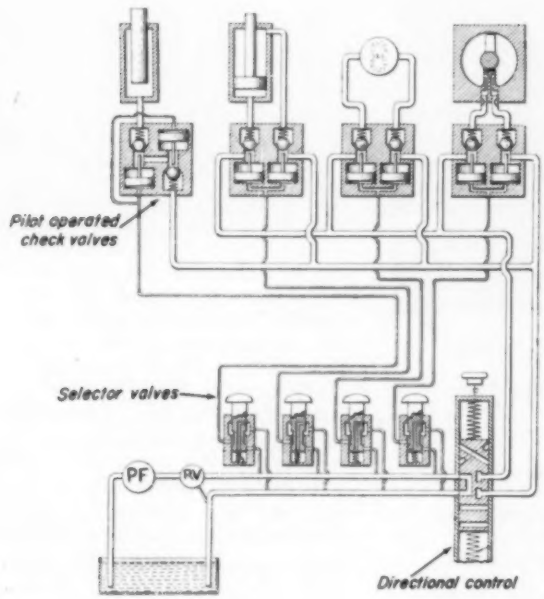
FLUID POWER PATENTS

Remote Pilot-Operated Selector Circuit

This circuit was originally developed for lift trucks having hydraulically operated front-end attachments. It may be adopted to any system requiring control of many actuators from a remote station.

• **Pilot-Operated Check Valves Select Actuators** —The illustration shows a single-acting cylinder, a double-acting cylinder, a fluid motor, and a rotary actuator operated from one pump. To operate one of the actuators, its selector valve is depressed, and the directional control valve shifted for the desired direction of actuator movement.

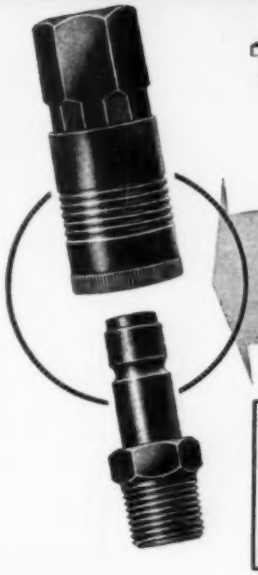


Depressing the selector valve applies pressure fluid to the pilot of a double pilot-operated check valve at the actuator. This pilot pressure opens the check valve and allows operation of the actuator. The pilot check valves are all similar except for the one controlling the single-acting cylinder. This valve checks flow in both directions. It prevents cylinder drop, and avoids raising the cylinder when the line of the valve is pressurized while operating one of the other actuators.

U. S. Patent No. 2,984,985 by Norman F. MacMillin, assigned to MacMillin Hydraulic Engineering Corp., Shiller Park, Ill. ▼▼▼

Circle 149 on Reader Service Card

TRU-FLATE



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new ROTORAM® VALVES

WITH EXCLUSIVE ROTATING STEM
for MILLIONS of TROUBLE-FREE ACTUATIONS

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- Low silhouette mounting
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- Anodized finish

Rotoram Valves are available in 3 and 4-way models for ⅛", ¼", ⅜" and ½" pipe sizes. Special Block "V" Packing permits free ram movement, insures long valve life. Port entry from either left or right side. Ask your AIR-MITE Distributor, or write for complete details and illustrated catalog.

AIR-MITE DEVICES, INC.
4401 W. Kinzie St., Chicago 24, Ill.

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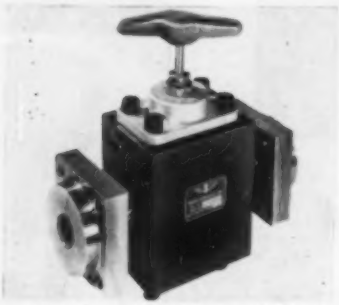
NEW PRODUCTS

Continued from page 64

VALVE WITH INTERCHANGEABLE FLANGES

Precision shut-off valve in basic 1" and 2" valve bodies has six types of interchangeable port-flanges that can be easily attached. One-piece seamless and weldless valve bodies are for use with oil, water, fuel, gases, and other fluids. A valve seat or body can be removed without breaking the line. Both basic valve bodies have many different flange configurations (1" has 225 combinations, 2" has 100 combinations) for various types and sizes of connections. All available from stock.

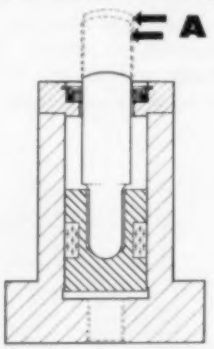


Specifications: Meet JIC standards. For operating pressures to 7500 psi. Maximum torque to operate the 2" valve at 7500 psi is 55 in.-lb.—*Greer Hydraulics, Inc., Los Angeles.*

Circle **305** on Reader Service Card

SELF-ALIGNING DIE CYLINDER

In this design a ball joint contact is used between the piston and the piston rod. This eliminates side loading, and high lateral forces between the piston and the cylinder bore. Instead of a conventional, piston rod bearing, a floating guide ring holds the piston rod in place during installation. It then acts as a wiper to prevent dirt from entering the cylinder. Under die operating conditions of impact and high pressure, cylinder service life without leakage, scoring, or maintenance is considerably improved.



Designation: HYSON SA—*Precision Products Inc., Cleveland.*

Circle **306** on Reader Service Card

T-TYPE SOLENOID

Designed especially for hydraulic & pneumatic valve applications. Available in four sizes with a push range of 2 to 12 lb.; ¼" stroke. With or without a captive or loose push pin of various lengths and diameters; either standard bobbin or epoxy model core.—*National Acme Co., Electrical Controls Div., Cleveland.*

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DRY AIR SYSTEM

Over 35% air volume gain can be obtained at no increase in compressor horsepower. System can be used in all single or multi-stage compressors, from 350 CFM

Continued on page 150

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with rigid, station-by-station inspection. CROSS hydraulic cylinder dependability is not left to chance. Every component must conform to the industry's highest standards — standards set at CROSS with faith in the workers' skills. Their pride of craftsmanship is your guarantee of quality. For a cylinder to withstand severe pressures, corrosive atmospheres — look to CROSS.

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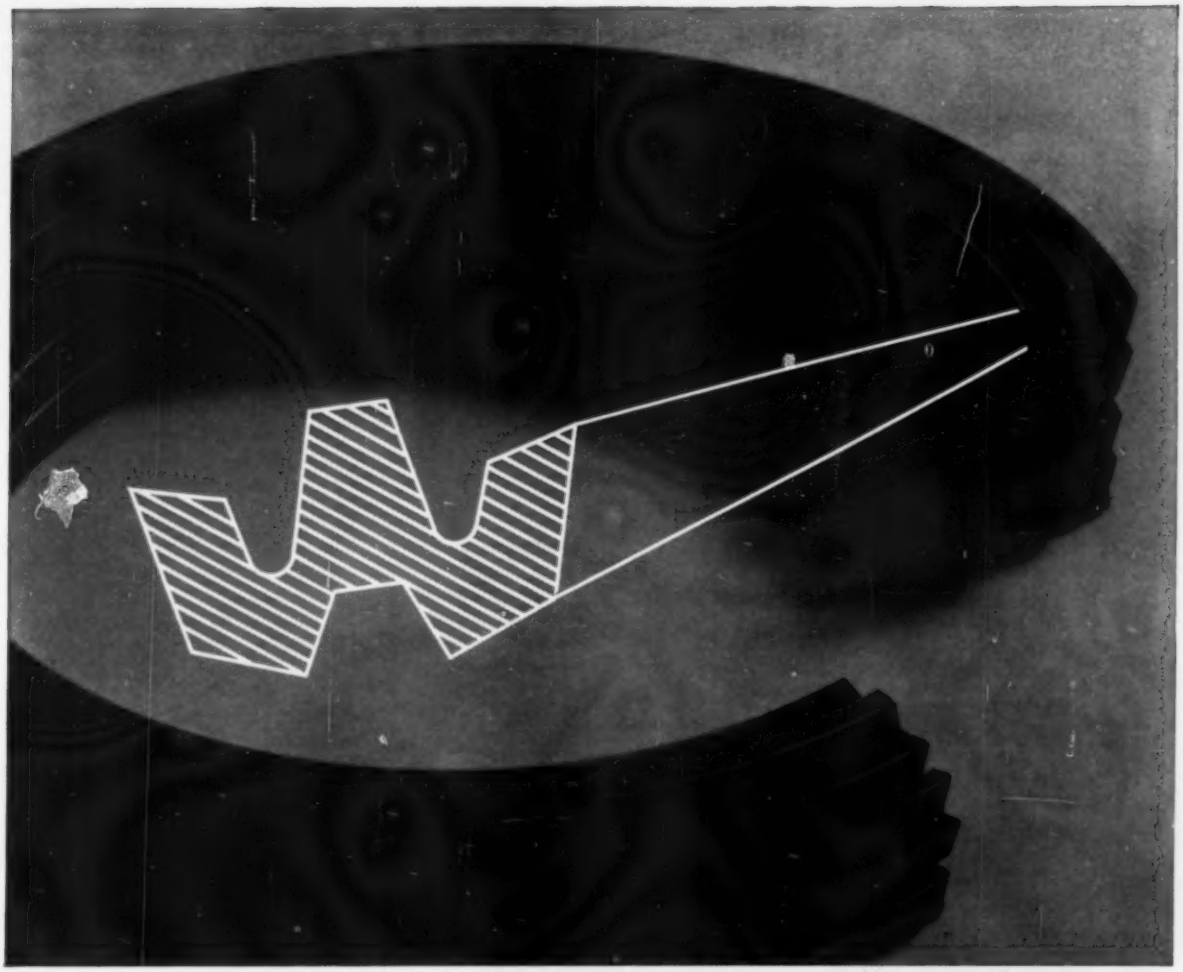


More sealing ability in less space with J-M UNEEPAC®

THIS CROSS-SECTION DESIGN DEMONSTRATES WHY UNEEPAC AFFORDS FULLY AUTOMATIC SEALING, EVEN IN LIMITED SPACE.

J-M Uneepac is designed and engineered to provide a truly automatic lip-packing element for use in applications requiring multiple ring sets in minimum stuffing box depths.

The design has many outstanding features. The rings nest together in an interlocking manner, but lips still have freedom to flex at the hinge and be pressure-actuated. Each ring is an individual sealing element, and does not require compression adjustment against adjacent rings to make it seal initially or during its life.

Easy-to-assemble Uneepac Rings offer peak sealing efficiency at optimum economy. They seal against the most rugged conditions, and give exceptional service life in rod and piston applications. They fit accurately and reduce friction. Uneepac Rings are precision-moulded, skillfully compounded in whatever materials best meet your requirements. A complete range of standard sizes, styles and materials is available for immediate shipment. Or, Johns-Manville will design and custom-make the exact packing you require.

And in light-duty applications where space is not available for multiple-ring sets, J-M Deep Base Uneepac Packing offers important economies. This simplified single-ring version of the Standard Uneepac design, engineered for reciprocating piston and rod application in air and low pressure hydraulic service, provides lower break-away load, less friction and smooth, dependable action.

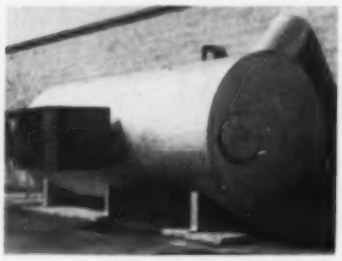
You will find all J-M moulded packings materials and designs in the new booklet PK-173A . . . with specific recommendations for most applications and service conditions. For a free copy, or for help with any sealing problem, see your J-M Distributor. Or write to Johns-Manville, Box 359, New York 16, N. Y. In Canada: Port Credit, Ont.

JOHNS-MANVILLE

JOHNS-MANVILLE JM PRODUCTS

NEW PRODUCTS

up. Intake air chilled, pre-shrunk, dried, forced into compressors. Unique design eliminates pressure drop, icing, clogging, and moisture carryover. This design also prevents vibration and pulsating noises common to compressors. Dry, frigid air at compressor inlet gives greater weight of air per stroke. Heat of compression is retained; and hot, dry air operates machines at maximum efficiency. —Coblentz Dry Air Systems *Lynch Corp., Anderson, Indiana.*



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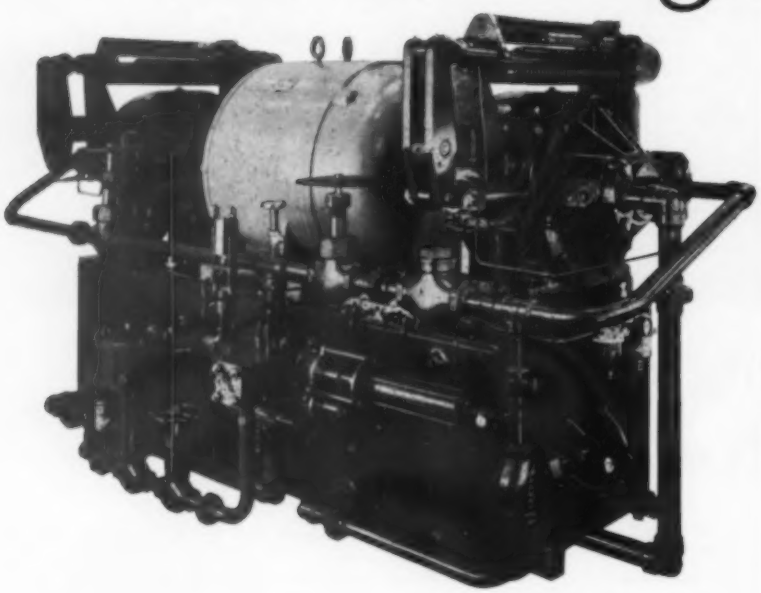
$16,000 worth of *Quality*



This special 120 horsepower pumping unit with its integral valves and controls provides 88 GPM of oil and remotely adjustable pressures to 2500 psi to serve an intensifier in a hydrostatic testing system.

It was purchased on the basis of its LOW PRICE for high quality and guaranteed continuous performance.

On your next hydraulic application be economical—
Buy Quality By Lassman.

Two year guarantee on equipment of our manufacture.

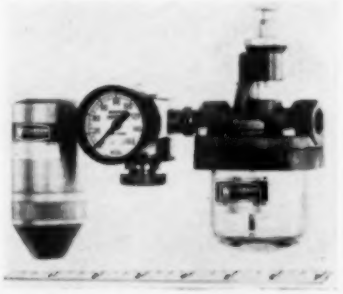
BENJAMIN LASSMAN & SON Route 8, GLENSHAW, PA

Circle **90** on Reader Service Card

COMPRESSED AIR UNIT

Filters, regulates, and lubricates compressed air. Completely automatic drain trap prevents moisture from accumulating in the sump of the filter, to a level where it will be returned to the air stream. Regulator and gauge control pressure. Lubricator atomizes fine particles of oil into the air stream. Visible oil reservoir may be filled from either side during operation.

Specifications: 7" long, 4¼" high. Filter is aluminum with Buna-N



seals. Pressure regulator and gauge are brass. Capacity of 12 cfm at 100-psi. 2½ lbs. Available from stock in ¼" PT.

Designation: Combomatic Model 64240-2.—*Wilkerson Corp., Englewood, Colorado.*

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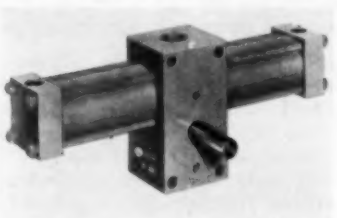
ROTARY ACTUATOR

Reversible rotary actuator, driven by air or hydraulic fluid. Opposing pistons move a gear rack over a pinion on a drive shaft, giving any desired rotation up to 360 degrees. Rotation may be stopped and reversed at any point. Three models develop 50 to 314 inch-pounds torque per 100 psi. Drive shaft keyed for use with stock worm or spur gears or special cam or lever attachments.



Designation: Air-Dex.—*Mo-Bar Hydraulics Co., Crystal Lake, Illinois.*

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NEW HEAVY DUTY TYPE KEBBY TANK-TRAPPER

. . . low cost magnetic unit for hydraulic reservoirs

- "DOUBLE MAGNETIZATION"
- CUTS MACHINE DOWN TIME
- REDUCES MAINTENANCE
- MORE DURABLE
- MASSIVE APPEARANCE

Write, wire or phone WO 3-1466 for information and prices.

KEBBY COMPANY
2320 Custer Ave. • Rockford, Illinois
MANUFACTURERS OF MAGNETIC DEVICES

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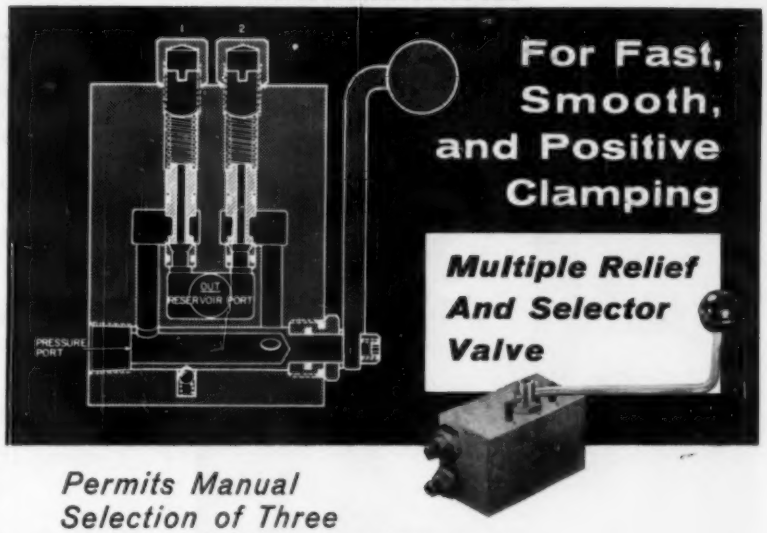

Permits Manual Selection of Three Individual Clamping Pressures

- **Flexible—both relief valves can be adjusted and locked**
- **Dependable — Safe**
- **Economical**

- For oil
- Pressure Ranges — 50 to 3000 psi
- Sizes — ⅜", ½" and ¾" S.A.E.
- Model with four clamping pressure selections available

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Manufacturers of Hydraulic Valves and Devices
Relief Valves • Check Valves • Restrictor Valves
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The ideal cylinder for unlimited automation, tooling and production line applications where space and economy are important! Compact—only 1-⅝" square. Pre-stressed construction for rugged service. Double acting or spring return. Universal, clevis, pivot and stud mounts. Rods vacuum hard chrome plated. Heads machined from square bar stock. Immediate delivery on 1", 2" and 3" strokes. Fractional or longer strokes available. 250 psi air; 1500 psi hydraulic. ***Write, NOW, for Bulletin No. 561.***

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Circle **138** on Reader Service Card

160 cubic inch reservoir with 8"x 8" base plate and 18" long handle.

Available with optional size pistons ⅜", ½", ¾", 1" and 1½".

We specialize in the manufacture of hand pump units which operate in temperatures from −65° F. to +160° F. and with any capacity reservoirs required. Pumps can be furnished on special order with custom seals to handle various aircraft types of fuels such as Pydraul, Skydrol, Oronite, etc.

The single pump with ½", ¾", 1" or 1½" piston is now available in stainless steel.

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1635 East 22nd St., Los Angeles 11, Calif.

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NEW AIRMATIC® TRIO CONTROL

Contains automatic moisture ejection filter, a piston-type self-relieving regulator and a mist-type lubricator. All anodized aluminum, it assures the best in conditioned air for all pneumatic devices.

ASK FOR BULLETIN 91055 for complete details—and check the price with your nearest Airmatic representative—you'll be pleasantly surprised.

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PRODUCT BRIEFS

ASBESTOS TEFLON & URETHANE SHEETS . . . This Teflon-filled asbestos has a high thermal expansion coefficient. It can be used in the −425 F to +500 F range. Solid urethane sheets include a fabric backed sheet 40" x 96" in 1/16, ⅛, and ¼" gages. They are particularly useful as liner materials.—*Auburn Mfg. Co., Middletown, Conn.*

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AIR CONTAMINATION SAMPLER . . . Measures amount of dust & other foreign material on a filter surface, expressed in the number of particles per cubic foot of air. All internal parts sealed and self-oiling for the life of the unit.—*Hydraulic Research & Mfg. Co., Div. of Bell Aerospace Corp., Burbank, California.*

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SMALL O-RINGS . . . Silic O Rings hold flash to a maximum of 0.001" on all units. Their main feature is dimensional stability. They are offered from stock in very small sizes not normally available.—*A.P.M. Corp., Englewood, N. J.*

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HIGH PRESSURE GAUGE . . . Life expectancy of more than 250,000 cycles; for pneumatic or hydraulic service in applications to 10,000 lbs. Available in 4½" and 6" dial sizes.—*American Standard Controls Div. Detroit.*

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THIS FREE GUIDE helps you build systems with "designed-in" pressure gauge protection

Write today for your copy.

CHEMIQUIP COMPANY

Pressure Snubber Headquarters
36 East 10th Street ■ New York 3 ■ GRamercy 7-3772

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DOUBLE FLOW REGULATOR . . . Control has two ¼" regulated ports and ¼" inlet and bypass ports, all bottom-located for easy mounting. Pressures to 3000 psi. Can govern two separate but associated functions. Twelve position detented dial adjustment.—*Fluid Controls, Inc., Mentor, Ohio.*

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DIRECT CURRENT MOTORS . . . Square frame, 9-¾" x 5" x 6.4", 27 vdc motors, ⅛ to 15 hp and speed range to 25,000 rpm. 14.9 lbs, low interference. Altitude to 150,000 feet for missile applications. Explosion resistant construction also available. Model 2510.—*Hoover Electric Co., Los Angeles.*

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PANEL MOUNTED NEEDLE VALVES . . . Assures bubble tight sealing against all gases up to 6000 psi. Bonnet and stem are protected from foreign particles. ⅛", ¼", ⅜" NPT; also AND 10050-4 and 10050-6 tube porting. Others customized. Soft seat repaired without removal from line.—*Dragon Engineering Co., Norwalk, California.*

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INCLINED TUBE MANOMETERS . . . Slant design gives wide spacing of scale divisions; sensitive and easy to read. Vertical ranges 2" to 20", and scale lengths 20" to 60". Precision-bore tube supported on a ground stainless-steel straight-edge. Each scale individually calibrated. Maximum working pressure 100 psig.—*King Engineering Corp., Ann Arbor, Michigan.*

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THREE SERIES

MARSH

Needle Valves

for every service

ALLOY STEEL

316 STAINLESS STEEL

416 STAINLESS STEEL

Now—with the addition of a 316 stainless steel series—you have a Marsh Needle Valve for almost any purpose or service. Full range of sizes and patterns. Wide range of pressures and temperatures. All are machined from solid bar stock. All have precision ground stems for close regulation—tight shut-off. All have "Marpak" moulded packing; Teflon in stainless steel valves.

Ask for bulletins covering full line.

MARSH INSTRUMENT COMPANY
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Division of Colorado Oil and Gas Corporation

Marsh Instrument & Valve Co. (Canada) Ltd., 6307 103rd St., Edmonton, Alberta, Canada. Houston Branch Plant 1121 Rockwell St., Sect. 15, Houston, Texas. Eastern Seaboard Warehouse: Marsh Instrument Company, 1209 Anderson Ave., Fort Lee, N.J.

See also current advertisements in Construction Methods and Equipment and Materials Handling Engineering magazines.

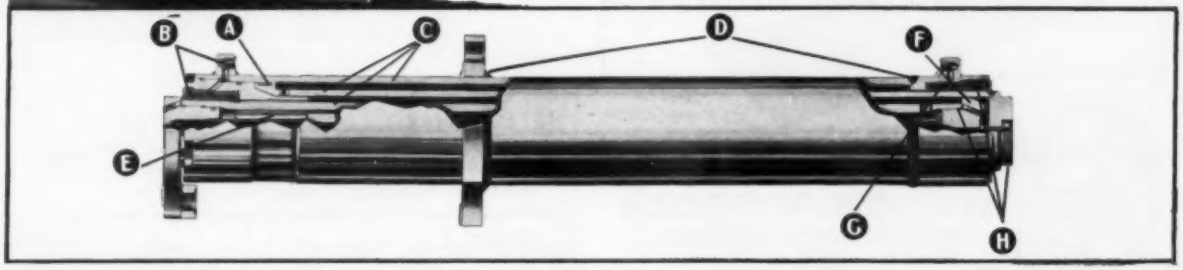
YALE approves WARD to muscle triple-lift on gas truck

Choice of suppliers is narrowed by high quality demanded

In a recent general reappraisal of sources, Ward Hydronics Inc was again approved as a supplier of the triple-lift hydraulic cylinder that gives the Yale gas truck its lifting muscle. Price, though sharp pencil, was not at issue since Ward is competitive. Neither was design, it's Yale's. Instead, the matter turned on two factors of interest to any producer of mobile heavy-duty equipment like this lift truck . . . quality manufacture of cylinders and delivery. On both counts, Ward meets Yale & Towne standards. For some details as to quality, look at the cut-a-way of the triple-lift Ward Hydronics cylinder. For delivery? For quotations? Write Ward Hydronics Inc., 11600 Genesee Street, Alden, N. Y. Telephone: Buffalo NT 3-9566.

- **A** Bronze guide assures stability at full extension
- **B** Static seal, return drains prevent external leakage
- **C** Honed and polished seamless steel tube hard chromed to 0.001-inch per side resists wear
- **D** MIG welds boost strength
- **E** Flow controller provides smooth, positive action
- **F** Positive-lock pilot is specially treated to outlaw galling
- **G** Specially compounded packings stop both high and low pressure leakage
- **H** Class 3 fits aid parts interchangeability

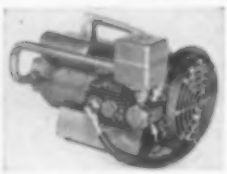
NOTE: *Design permits complete field disassembly.*



Portable motor compressor

B&G® COMPRESSED AIR COMPLETELY *Oil-Free*

58 models to select from

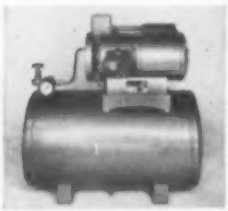


Tankless motor compressor

There's never any oil-spoiled work with B&G Compressors—they *never need oiling.* Powered by B&G built motors, they are constructed with carbon graphite piston rings and skirts which need no lubrication; bearings are grease-packed and sealed for life.

Numerous additional design and construction features assure long-lived, dependable delivery of cleaner, cooler, drier air and smooth operation.

You'll find the compressor you need in the B&G line! Choose from 58 models—lightweight portables, bare compressors, tankless motor compressor outfits, air tank motor compressor outfits; from 1/19 to 3/4 HP, up to 6.57 CFM, pressures to 190 psi.



Air tank motor compressor outfits

Gasoline engine-driven compressor outfits

PULLS UP TO 28" OF VACUUM... CONTINUOUSLY

B&G Vacuum Oil-less Vacuum Pumps are free of expensive lubrication maintenance and do away with messy oil-laden discharge vapors.

Two B&G Vacuum Pumps are integral components of this vacuum lifter which handles 2,000 lb. metal sheets.

Send for Catalog GO-259

***Oil-less* AIR COMPRESSORS**

BELL & GOSSETT COMPANY

Dept. GW-66, Morton Grove, Illinois

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PRODUCT BRIEFS

SERVO AMPLIFIER . . . Model EAPS-A-10 amplifier includes a built-in regulated power supply and is impedance matched for operation with all standard Vickers industrial servovalves. It fits standard electrical mounting racks. Power requirement: 115 volts ac at 1 amp. Controls provided: balance, gain, dither, and equalizer.—*Vickers, Inc., Div. Sperry Rand Corp., Detroit.*

Circle **319** on Reader Service Card

2-WAY SOLENOID VALVE . . . Normally open. ½" pipe size. Brass body, integral seat, Teflon disc. For air, water, light oil to 500 psi, 212 F. Standard listings for dc. *Automatic Switch Co., Florham Park, N. J.*

Circle **320** on Reader Service Card

PULSATION DAMPENERS FOR GAUGES . . . Stainless steel or rolled brass. For gases and liquids to 10,000 psi. Variable orifice permits full pressure measurement, throttles abrupt pressure changes. External adjustment without line or gauge disconnection. Hex cap protects adjustment. O-ring seal. ¼" and ⅛" sizes. *Kunkle Valve Co., Ft. Wayne.*

Circle **321** on Reader Service Card

CYLINDERS . . . Series A2, for 250-psi air, 2400-psi oil. Interchangeable cushion adjustment and ball check flush in cylinder end plates. Removable cartridge has compensating lip-type wiper seal, self-adjusting multiple-lip rod seal, extra-long bronze bearing. 11 bore sizes 1½"-14". 25 mountings. Full-area ports. Heli-coil insert piston lock.—*S-P Mfg. Corp., Cleveland.*

Circle **322** on Reader Service Card

SHUT-OFF VALVE . . . General purpose, air-operated, remote controlled, normally closed soft seat shut-off valve. If air-power fails, a spring closes the valve. Operating pressure 6000 psi; temperature range from −65 F to 450 F. In several metals with ⅛", ¼", ⅜" NPT or AND 10050-4 and 10050-6 tube porting. Others to order.—*Dragon Engineering Co., Norwalk, California.*

Circle **323** on Reader Service Card

COMPRESSED AIR DRYER . . . Dehumidifies 25 scfm of 100 psig air to a dew point of −12 F (atmospheric). Operates on 115-volt, 60-cycle current; 22" x 14-¾" x 28". Cooled moisture removed through discharge trap. Input directly from compressor at pressures to 150 psig. Cooling to nearly constant temperature regardless of fluctuations in air flow.—*Zeks Industries, Inc., Edgemont, Pa.*

Circle **324** on Reader Service Card

IMPREGNATED LEATHER PACKINGS . . . New impregnant reduces frictional drag, does not wash away under severe pressures. It will not melt, and contains no graphite or fillers. Because it will not separate or break down and is not soluable in water, service life can be greatly improved.—*Garlock Inc., Palmyra, N. Y.*

Circle **325** on Reader Service Card

KEYED TIMER . . . Two new optional features on stocked timer are a lock in which key sets the dial, and pilot light. The pilot light indicates either that the timer is setting or that it is resting in either the *timed out* or *reset* position.—*Eagle Signal Co., Moline, Illinois.* ▼▼▼

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Circle **47** on Reader Service Card

building special machinery ?

HERE'S *NEW* SOLUTION FOR

SMOOTH CONTROL

New E-M cylinder is air-activated, hydraulically controlled . . . eliminates erratic operation often caused by air pressure changes. This combination makes possible any cycle of *fast*, *slow* and *skip* feed with rapid advance to any point in the stroke . . . also assures controlled feed. The cycle can be repeated several times during one *out* stroke. 2 bore sizes, each available in 2", 4", 6" or 8" stroke lengths. FREE LITERATURE.

The ELECTRO-MECHANO CO.
163 E. Erie St., Milwaukee 2, Wis.

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NEW FILTER

with

FILTER CONDITION INDICATOR*

eliminates need for periodic service

A quick glance at the pressure gage on this new hydraulic line filter tells you when its element needs cleaning or replacement . . . warns of impending pressure build-up *before* the built-in by-pass valve can open and allow circulation of unfiltered fluid . . . makes unnecessary the costly and wasteful procedure of inspecting or changing elements at periodic intervals.

It's a big half-gallon filter, with choice of interchangeable monel wire cloth or phenol treated paper elements. Inlet and outlet ports are full 1¼" NPTF. Pressure drop at flow rate of 60 gpm is only 5 psi when using the 200-square-inch, 100-mesh, wire cloth element.

Filter may be installed in either the suction line (between tank and pump) or the return line (between control valve and tank), and the element is easily accessible.

***Amazing fact:** *The price of this new filter is even lower than many filters without this outstanding feature.*

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MANUFACTURING CO.
405 - 36th AVENUE N.E., MINNEAPOLIS 18, MINN.

GRESEN HYDRAULICS

"Dyflon" Self-Lubricating JOURNAL BUSHINGS

Design engineers in many industries are specifying new "DYFLON"® Plastic Alloy Liner Self-Lubricating Journal Bushings for these 4 major reasons:

1. **LOWER COEFFICIENT OF FRICTION...** ideal where lubrication is impossible.
2. **WITHSTAND EXTREME VIBRATION...** perfect performance under shock load conditions.
3. **WILL NOT "COLD-FLOW"...** even under extreme load conditions.
4. **IMPERVIOUS TO KNOWN CHEMICAL SOLVENTS...** eliminates corrosion problems.

"Dyflon"® journal bushings give you long cycle life under extreme load conditions, due to their design and plastic alloy liner. Handle dynamic loads to 20,000 psi without galling, fretting or brinelling. Oil-free for life. Static yield loads to 50,000 psi at low rotational speeds without damage. Available in plain and flanged types. Bore sizes to 3". Retainer materials include stainless steel, aluminum and phenolic. Engineered to same high standards as Southwest's popular "MONOBALL"® Self-Aligning Bearings.

Write for Bulletin 1060 today.

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SOUTHWEST

"Monoball"®

SELF-ALIGNING BEARINGS

CHARACTERISTICS

	ANALYSIS	RECOMMENDED USE
1	Stainless Steel Ball and Race	For types operating under high temperature (800-1200 degrees F.).
2	Chrome Alloy Steel Ball and Race	For types operating under high radial ultimate loads (3000-893,000 lbs.).
3	Bronze Race and Chrome Steel Ball	For types operating under normal loads with minimum friction requirements.
4	"Dyflon"® Plastic Alloy Inserts. CRES Ball and Race. Chrome Alloy Steels.	For types operating under rotational, high radial loads and long cycle life where lubrication is impossible.

Thousands in use. Backed by years of service life. Wide variety of Plain Types in bore sizes 3/16" to 6" Dia. Our engineers welcome an opportunity of studying individual requirements and prescribing a type or types which will serve under your demanding conditions. Southwest can design special types to fit individual specifications. Write for Engineering Manual No. 551. Address Dept. HP-61.

SOUTHWEST PRODUCTS CO.
1705 SO. MOUNTAIN AVE., MONROVIA, CALIFORNIA

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WATERMAN

Series 190

FLOW REGULATORS

Constant Speed Operation

regardless of load!

At a cost comparable to an ordinary restrictor or needle valve, you can have pressure-compensated flow control in your hydraulic circuits.

Rated for pressures to 3000 p.s.i.

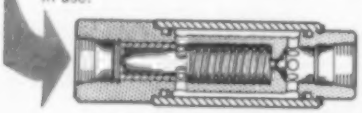
Wide range of sizes available—¼" to 1½" N.P.T.F. and ¼" to 1" S.A.E. tube.

Flows to 100 g.p.m. can be controlled.

Factory-calibrated and tested to ±10% tolerance. Closer tolerance available.

Require little more space than pipe or tube in which installed.

Trouble-free in operation—tens of thousands in use.



Unit senses pressure drop across precise orifice and reacts to control flow with desired limits.

Send today for new Catalog 1002.

NFPA

W-8105

WATERMAN

725 Custer Ave., Evanston, Ill.

Circle **154** on Reader Service Card

NEW LITERATURE

Continued from page 70

2500-PSI PUMPS & MOTORS

Designed for continuous duty operations. Graphically illustrated with photos, line drawings, and performance data charts. Other charts list a variety of flange mountings, port-end covers, gear housings, drive shafts, and gear widths available in the series. Tandem assembly with a single connecting shaft is also featured in the new bulletin. Bulletin 100-p19—*Commercial Shearing & Stamping Co., Youngstown, Ohio.*

Circle **411** on Reader Service Card

HYDROSTATIC TRANSMISSION

System advantages are full torque at low engine speeds & idle, no racing with loss of traction, infinitely variable speed from constant rpm motor without clutches or gear changers, elimination of wear-prone drive line components, positive braking, mounting flexibility. Performance characteristics of output unit can be measured at input unit. Specifications, performance graphs, and dimensions given. Bulletin DP–2–*New York Air Brake Co., Watertown, N. Y.*

Circle **412** on Reader Service Card

PACKINGS

Catalog illustrates and describes complete line of pneumatic and hydraulic packings; also serves as a design handbook and guide. Discusses materials used in making packings: leather, fabric, rubber, and Teflon. Covers cup, flange, *U*, *V* packings, O-rings, backup washers, and one-piece double-acting piston cups. Data on packings in standard sizes. Design, applications, and specifications. Bulletin 341—*Chicago-Allis Mfg. Corp., Chicago.*

Circle **413** on Reader Service Card

REMOTE CONTROL UNITS

Complete line of hydraulic remote control units is listed, in-

Continued on page 158

CLA
$5.95 list price 1" stroke

CLA-T
$6.95 list price 1" stroke

VALV-N-HED®
$19.45 list price 1" stroke

NEW... IMPROVED
UNIVERSAL, CLEVIS, PIVOT or STUD MOUNT 1⅛" CLAMP TYPE
AIR CYLINDERS

- **COMPACT**—only 1-⅛ inches square.
- **VERY SHORT** overall length.
- **MOUNTS** front or rear flange, side, clevis, pivot, or stud.
- **TIE ROD** construction.
- **HEADS** machined from aluminum bar stock. Tubes, Mirror smooth brass.
- **PISTON ROD**—super-finished stainless steel for maximum corrosion resistance.
- 150 psi AIR.
- **ADEQUATE** safety factor.
- **IMMEDIATE** delivery on 1", 2", and 3" stroke. Fractional or longer strokes available on short notice.

INEXPENSIVE ANSWER TO TOOLING and AUTOMATION!

CLA SERIES
DOUBLE ACTING, SPRING RETURN and SOLENOID OPERATED

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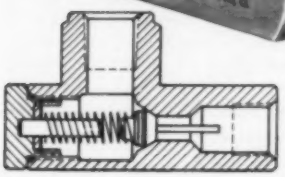
positive-action compact right angle CHECK-RELIEF VALVE



simplifies installation and allows easy access to internal parts without removal from line.

- **internal cracking pressure adjustment is completely tamper-proof.**
- **guided poppet with non-extrudable seal insures quiet, chatter-proof action and a positive shut-off.**
- **excellent re-seating characteristics.**
- **minimum pressure drop prevents loss of fluid power.**

- for use with air, oil, gas, water, other fluids.
- operating pressure up to 5000 psi.
- cracking pressure ranges from 5 to 150 psi.
- standard sizes: ¼, ⅜, ½, ¾, 1, 1¼.

Write today for complete details.

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TRADEMARK SINCE 1829

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LEIMAN AIR PUMPS with the Exclusive HINGED VANE DESIGN

WEAR-FREE! CARE-FREE! REPAIR-FREE!

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Self-honing surfaces. Curved cast iron vanes rotating against cast iron cylinder walls hone wear surfaces to a hard, glassy smoothness. Provides continuous leak-proof seal and low-friction operation.

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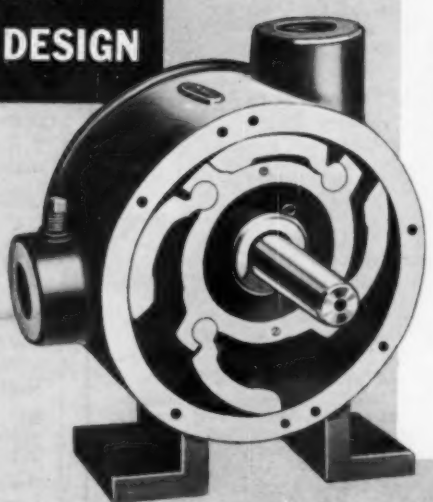

• The simplified Leiman hinged vane design provides larger air space, higher capacity—permits use of smaller pumps, slower speeds, lower horsepower. Every pump rigidly test-run before shipment. Specify Leiman Air Pumps for your vacuum, suction or pressure operations for lifetime dependability. Consult Leiman engineers on any application.

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LEIMAN BROS., INC.
151 Christie St., Newark 5, N.J.
Established 1889

LEIMAN Rotary Positive AIR PUMPS
Vacuum to 29.9" Hg. Pressure to 20 p.s.i.g. Volume to 162 c.f.m.

NOPAK OFFERS YOU COMPLETE AIR CIRCUITRY

another Plus Value by NOPAK

NOPAK "V"

NOPAXAM

NOPAK-MATIC

The addition of Nopaxam palm button, cam, lever and air operated valves "closes the Nopak circuit." Precise control — mechanically or electrically signaled — can now be *completely* Nopak. Singularly or in combination, Nopaxam, Nopak "V" valves and Nopak-matic valves will meet your most complex circuit requirements.

Nopak "V," 4-Way, Pilot Operated Slide Valves

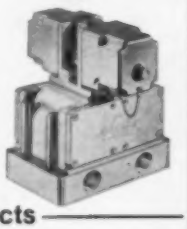
For direct or remote control. Either single or double air pilot or solenoid actuated. Simple, proven design, durable construction insure trouble free operation. See Catalog 102-A.

Nopaxam Precision Spool Valves

For air or hydraulic service to 150 psi. Pilot or mechanically operated, these valves are small, compact, easily mounted, have extremely short throw and high flow rates. See Catalog N.

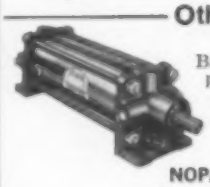
NOPAK-MATIC Poppet-Type, Pilot Operated Valves

Fast acting, high volume air valves from ¼" to 1¼" with master (air piloted), single or double solenoid. Side or bottom ported subplates or manifolds. Removing cover plates affords easy access to piston poppets housed within removable, interchangeable cartridges. 100% J.I.C. See Catalog 105.



Other NOPAK "CVA*" Products

NOPAK Class 1 Cylinders

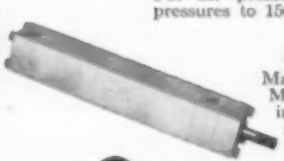


Brass Tubing and Tie-Rod Construction. For pressures to 250 psi. Choice of adjustable cushion, self-regulating or non-cushion heads. Diameters from 1½" to 16". 6 Standard Mountings. See Catalog 101-A.

NOPAK Class 6 Bore-Rated Cylinders

Compact steel plate, square head with tie-rod and honed steel tubing construction. For air pressures to 250 psi. hydraulic pressures to 1500 psi. See Catalog 106.

NOPAK Class 7, Square Barrel Cylinders



Made with pressure-cast and extruded aluminum. Mounting holes can be drilled or tapped directly into cylinder tubing. ¾" to 3" bores pressure rated for 200 psi. air or 1000 psi. oil. 7 universal mountings. See Catalog 107.

*CVA Cylinders, Valves, Accessories
NOPAK offers a complete line of Matched Fluid Power Components.

NOPAK VALVES & CYLINDERS

NOPAK DIVISION
Galland-Henning Mfg. Co.
2743 S. 31st St., Milwaukee 46, Wis.

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NEW LITERATURE

cluding semi-rotary and linear actuators, their fittings, power and manual pump units and control units. Line eliminates the need for heavy and complicated linkages. Off the shelf availability. Information on complete hydraulic systems and control and service equipment.—*Armstrong Hydraulics Inc., Chicago.*

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HYDRAULIC CHECKING UNITS

Catalogue describes complete line of hydraulic checking units. Cushioned checking action prevent shock or chatter. Details principles of operation, engineering features, applications. Also includes information on hydraulic flow and metering control valves and decelerating valves.—*Pokorny POW-R-TROL Products, Inc., Cleveland.*

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PURIFICATION SYSTEMS

Heatless dryers and hydrogenous adsorbers are shown. Capacities to 30 SCFM. Also self-contained central systems for producting clean, pure, low dewpoint air. Triple by-pass for component servicing without shut-down. Designed in accordance with military specifications. Also miniature, oil-free compressors. Volumes to 3 SCFM; pressures to 100-psig; weight 3 to 8 lbs. Catalog 61—*Applied Pneumatics, Inc., Kenilworth, N. J.*

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AXIAL PISTON PUMP

Folder describes and illustrates operating cycle and multiple-circuitry combination possibilities of a single pump. Short stroke of relatively long pistons minimizes leakage, maximizes efficiency. Check valve design eliminates need for valve plate and its relatively short seals. Elimination of hydrostatic bearing design. Runs cooler and more quietly. Pump selector chart for complete line. Foot mountings standard. *Anatomy of Dependability—The Dynex Co., Pewaukee, Wisc.*

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Need Help with HIGH PRESSURE PROBLEMS?

3000 PSI to 15,000 PSI

Star HI-LO Two Speed Manual Hydraulic Pump operated by single lever.

Hydraulic Pumps, Cylinders and Rams — one or a hundred — rugged precision machined units designed, adapted or built to your drawings or performance specifications. *Star* quality is the reason Star units are integral in many high-performance machines.

Qualified Star Hydraulic Engineers are available to help you. Send us your pressure problems. We will present recommendations and a proposal based on your requirements.

Write for Bulletin 160.

HYDRAULIC RAMS • MANUAL PUMPS • CYLINDERS • STAR

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SINGLE PISTON HYDRAULIC PUMPS

SOLID AND CENTER-HOLE RAMS

200 TON REMOTE RAM and PUMP

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specialise in the manufacture of

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for Hydraulic & Pneumatic Equipment

Illustration shows two examples from the wide range of valves

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- 2-way selector valve feeds pressure to selected service (e.g. double-acting ram) leaving alternate selector position open to exhaust
- Selector handle in neutral position opens both selector connections to exhaust
- Other selector arrangements designed to customers' requirements

MBL.3405 *Prov. Pat. No. 34977/59* (Bottom)

- Single lever-operated valve actuates set of 4 chocks or single acting rams in pairs or sets of 4
- Separate selector valve incorporated to operate double-acting ram
- All operations, both pressure and exhaust, controlled by single selector lever
- 2 relief valves yielding at 6,500 p.s.i., fitted to valve body or installed separately
- Normal fluid — water and soluble oil

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- Capacities .1 to 65 gpm
- Pressures to 3000 psi

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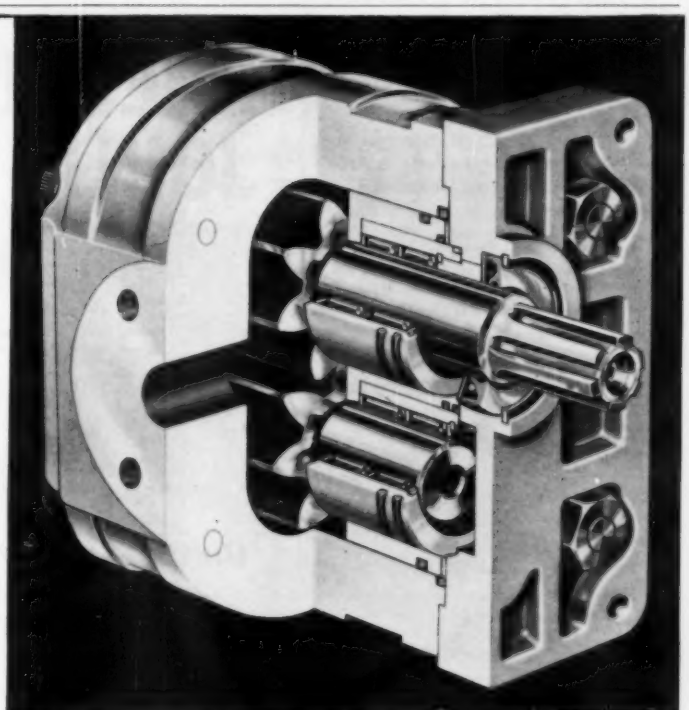
  Pressures to 2800 psi
- FLOW & PRESSURE CONTROLS
  Pressures to 2800 psi



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Includes:

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Charts will give you material and dimensional specifications, capabilities, operating and constructional features of:

Accumulators
Aftercoolers
Air Compressors
Air Motors
Air-Line Lubricators
Boosters
Cylinders
Filters
Flexible Shaft Couplings
Fluid Motors
Hand Pumps
Hose, Fittings & Assemblies
Hydraulic Fluids
Oil Coolers
Packings & Seals
Pressure Gauges
Pressure Switches
Pumps
Quick-Connect Couplings
Rotary Actuators
Rotary Joints
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Valves

Extra copies will be available at $1.00 each.

NEW LITERATURE

200-PSI AIR CYLINDERS

New cylinders outlined in brochure including single and double-end-rod cylinders, mounting kits, and rod end accessories. Five bore sizes 1¾" to 4½". Stroke to 20" standard; custom-made longer. Temperatures to 165 F maximum; should be kept under 130 F for best seal life. Floating cushions supplied without increase in cylinder length. Bulletin 0220-B1—*Hannifin Co., Div. of Parker-Hannifin Corp., Des Plaines, Ill.*

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VARIABLE DISPLACEMENT PUMP SERVO CONTROLS

Bulletin covers all position and pressure control servo systems; multiple command pump stroke control; special servo assemblies and adjustable relief valves.

Electric command of spring-centered torque motor deflects servovalve swing plate in proportion to current from the transistor amplifier. Linear variable differential transformer (LVDT) transmits voltage proportional to slide block position. A potentiometer gives command voltage. Slide block moves until LVDT voltage equals potentiometer voltage. If power fails or an emergency stop switch is actuated, a solenoid valve drops out, and the pump returns to neutral. Includes translatory and rotary drive components. Specification charts, diagrams, pictures. Bulletin 47740.—*The Oilgear Co., Milwaukee.*

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SOLENOID VALVES

Packless, internal piston, pilot-operated valves, of extra heavy bronze, in seven sizes ⅜" to 2". Type Q air and water, 5- to 400-psi general purpose. Dimensions, parts list, and weights. Coils guaranteed for 1 year. Ordering data. Bulletin 710 Q—*J. D. Gould Company, Indianapolis.*

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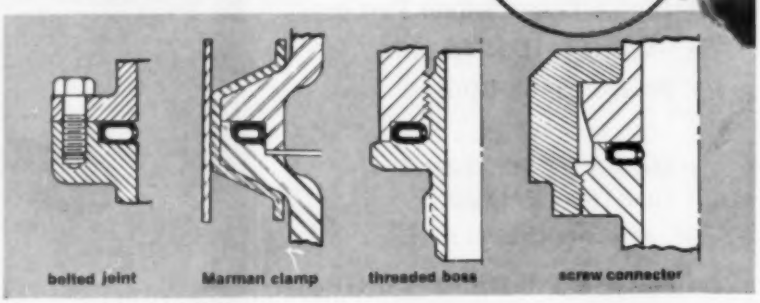
PRESSURE-TIGHT JOINTS 10⁻⁶ mm Hg-100,000 psi



United Self-Energized Metallic O-Rings...*

form positive, permanent, non-corrosive, static seals under pressure extremes from 10^{-6} mm Hg to 100,000 psi (or the ultimate compression stress of the metal itself) and temperatures from −452° to 3000° F. Available in various metals and coatings (including Teflon** and silver) ¼" O.D. to any size and configuration. United also makes non-vented and pressure-filled O-rings.

United Metallic "O" Rings, manufactured by United Aircraft Products, Inc., Box 1035, Dayton, Ohio.

See United Metallic O-Ring Catalog in Sweet's Product Design File or write for Free Handbook

*Patents 2,809,269; 2,837,360
**DuPont registered trademark

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Circle **15** on Reader Service Card

AUTO-PONENT®

HYDRAULIC FULL FLOW VALVES

Flow Control, Needle, Check, for HYDRAULIC Power

Model KF Flow Control Valve with Dial and Knob adjustment for direct reading and duplicating reference. Now available in Aluminum for 3000 psi.

Pat. #2,841, 174

A complete line: ⅛", ¼", ⅜", ½", and ¾" female Dryseal Pipe Sizes in all models and types. Equivalent Aeronautical Tube Sizes on special order.

MINIMUM PRESSURE DROP AND POWER LOSS . . . Oversize ports and passages give maximum flow at minimum pressure drop, insure greater accuracy and response in hydraulic or large volume air cylinder control.

EASY FLOW ADJUSTMENTS under full pressure. Seal located at port to eliminate air or dirt traps. Gland structure equally effective on pressure or vacuum.

SENSITIVE, CHATTERLESS BALL CHECK . . . Patented design insures rapid ball movement to open or close at low differentials.

FORGED BODIES permit higher pressures with wide safety margins. Aluminum—3000 psi; Steel and Stainless Steel—5,000 psi. Pressure ratings based on better than 5 to 1 safety factor. All internal parts are Stainless. Write for illustrated catalog.

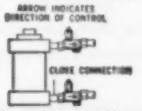
Model F Standard Flow Control Valve or Model H Needle Valve

Model KF Knob and Dial Flow Control Valve or Model KH Needle Valve.

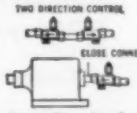
Model PF Knob and Dial Flow Control Valve or Model PH Needle Valve for panel mounting.

Model C Check Valve for In-Line Mounting.

TYPICAL APPLICATIONS



Controlling Double Acting Cylinder



Controlling Single Acting Cylinder

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2919 GRANT STREET
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INFINITELY VARIABLE DELIVERY

The Savery Variable Delivery Pump gives FLEXIBLE control which is completely POSITIVE over a wide range for use on hydraulically controlled Machinery, Agricultural and Factory lifting gear, Oil Burner equipment and hydraulics for AUTOMATION

SAVERY PUMPS have a proven record of great reliability in the METERING of chemicals and are used by VIKING ENGINEERING CO., Salford, in their renowed equipment for the production of POLYURETHANE Foams. If you will send full particulars of the properties of any chemicals you wish to pump or meter our Research Department will give you a prompt opinion of the ability of our equipment to handle them.

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HYDRAULIC PUMPS

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The Wilkerson *SELF-DRAINING* AQUA-JET FILTER *PROTECTS* your air equipment

Wilkerson obsoletes bulky, costly attachments

Harmful oil, water, and dirt as small as 5 microns are *completely* separated and pneumatically discharged from compressed air lines.

MINIMUM AIR LOSS . . .
Dependable Draining as Needed

Large drain opening, soft Buna N valve seat and positive "snap-action" of float prevents costly air loss. Will flow up to 635 CFM with only 0.75 to 1.65 PSI pressure drop. Full sump capacity can be expelled every 3 seconds,—eliminates undependable human element for draining.

NEW ANTI-CORROSIVE COATING

All internal, moving parts especially coated to prevent electrolysis and provide long life.

VERSATILE

Can be used as single unit or in combinations;—transparent or metal bowl from ¼" to 8" P.T. Maximum pressure 250 PSI.

WRITE TODAY

for complete AQUA-JET information contained in new circular #1027, and name of your nearest Wilkerson distributor.

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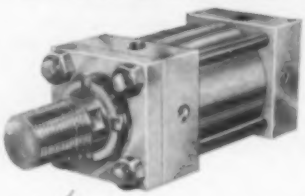
A-OK

AIR and HYDRAULIC
CYLINDERS
and
BOOSTERS



A-OK Speed
A-OK Performance
A-OK All Sizes
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A-OK All Pressures (Standard up to 3000 psi.)
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A-5328A

The S-P Manufacturing Corp.
A BASSETT COMPANY
ESTABLISHED 1916
30201 Aurora Road • Cleveland 39, Ohio

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POST SCRIPTS OF INDUSTRY

News about people, manufacturers and sales organizations

Changes in Vickers Industrial Sales Dept.

Vickers Incorporated, Division of Sperry Rand Corp., has announced the appointment of Roy Golze to the newly created position of midwestern regional manager in the Industrial Sales Dept., Machinery Hydraulics Division. He will direct sales activities in the Chicago, Rockford, and St. Louis areas from Vickers Chicago office. Mr. Golze moves up from

White

Golze

his position as district manager in Philadelphia. Replacing Golze as district manager in Philadelphia is Robert G. White who previously had been an application engineer in Vickers' Detroit office.

Denning

Horkavi

Francis J. Horkavi has been added to the application engineering staff of the Chicago office, and James A. Denning has been assigned as an application engineer for the Machinery Hydraulics Division in Vickers office in Atlanta.

Jones appointed to sales post

M. Lloyd Jones Jr. was appointed as reusable hose products sales manager, Parker Fittings & Hose Div., Parker-Hannifin Corp., Cleveland. He was manager of distributor sales for Aeroquip Corp., Jackson, Mich., and more recently manager of an Aeroquip west coast operation.

Fuller appoints engineering director, announces changes in California

Fuller Co. has appointed General Harry A. Markle, Jr. to the position of director of engineering. This includes direction of all company divisions, subsidiaries, and affiliates. In 1945 he was appointed asst. chief engineer, and in 1952 was made chief engineer.

Ralph R. Clark, Jr. has been transferred from Fuller's home office to its Western Division headquarters in San Francisco.

Mr. Clark, a Fuller sales representative since 1954, will handle direct customer sales and service. Fuller's Los Angeles branch has been enlarged with the addition of Ernest A. Nelson to its sales and service staff.

New production chief at Almo Manifold

S. Tom Truby, Jr. has been appointed superintendent in charge of manufacturing operations for Almo Manifold & Tool Co., Centerline, Mich. Truby was formerly assistant chief metallurgist with Jones & Laughlin Steel Co., Stainless Division, and chief field metallurgist at American Chrome Co.

Field engineering changes at Denison

James C. Jones has been named a field engineer for the Denison Engineering Div., American Brake Shoe Co. Jones will be responsible

Continued on page 164

for the sale of hydraulic presses and accessories in the eastern half of Michigan.

As field engineer in Denison's Cincinnati office, James H. Woodward, Jr. will handle sales engineering for hydraulic pumps, motors, and controls in southern Ohio and northern Kentucky.

Jones

Woodward

Richard L. Van Voorhis has also been named a field engineer. He will handle sales engineering projects in the Ohio area. He joined Denison two years ago, serving recently in the Columbus sales office.

District Sales manager named by J. N. Fauver

Frederick R. Hodgkinson has been named Chicago district sales manager of J. N. Fauver Co., Inc., Detroit. His duties include directing all district sales and service of Hydro-Line Mfg. Co., Rockford, Ill. He was with Dole Valve Co.

Parker Seal appoints sales manager

William Swan who joined Parker Seal Co. in 1956 as sales engineer in the Dayton area, and who was advanced to assistant sales manager with headquarters in Culver City, California, has been appointed Western sales manager.

Jack & Heintz to set up distributor network

The Jack & Heintz Division of the Siegler Corp., Cleveland, announced it would establish a national network of distributors for its new line of standard, industrial type, quick-connect couplings. H. H. "Bert" Witte, associated with engineering, production, and marketing of couplings and fluid system components for 20 years, has been named to es-

Continued on next page

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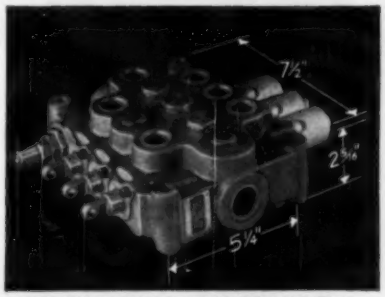
Need up to 23 G.P.M. in Fluid Control?



COMPACT HUSCO 3300-SP MULTI-PLUNGER VALVE IS FOR YOU!

One of five basic sizes, HUSCO 3300-SP Valve offers unusual design and performance features that adapt it to wide application. Available to control up to *six* individual cylinders, single or double acting, permitting up to *four* positions of control for extreme versatility. Conventional or parallel circuit, check valve controlled. Compact, precision built for long, trouble-free service. Other HUSCO Multi-Plunger Valves in capacities from 3 to 185 G.P.M.

Write for detailed specifications on HUSCO 3300-SP and complete catalog "Husco's House of Ideas" — or engineering aid on your hydraulic control needs.

HUSCO

HYDRAULIC UNIT SPECIALTIES CO.

PUMPS • VALVES • CYLINDERS

P. O. Box 257-A, Waukesha, Wisconsin

West Coast Representatives

• EASTMAN PACIFIC CO., Los Angeles, Calif.

ROY BOBBS AIR-DRAULIC CO., Portland, Ore.

YOUR BEST BET!

Seal-Guard

THE ULTIMATE PROTECTION FOR VITAL HYDRAULIC PARTS

Two flexible, bronze, knife-edged wiper rings, mounted in a synthetic rubber cushion ring, throw all foreign matter clear of the rod.

Seal-Guard's unique metallic rod wipers are easy to install and self-adjusting. Their floating cushion absorbs side thrust, prevents scarring of the rod. Practically friction-less, they resist oil and heat for long, trouble-free service.

Standard sizes for ¼" to 6" diameter rods. May be special-ordered up to 24¼" in diameter.

HYDRAULIC ACCESSORIES CO.

24301 Hoover Road, Warren Mich.

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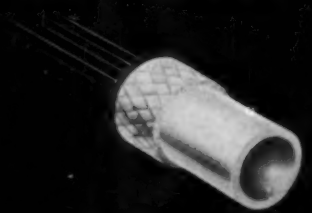
SYNFLEX *Pressure Hose*



Improved hydraulic hose incorporating precision-drawn nylon inner tube, nonmetallic reinforcing braid, abrasion-resistant extruded cover. Electrical non-conductor.

■ **Synflex Pressure Hose** is a new concept in high pressure hose for multi-purpose applications. Combines strength with light weight . . . no metal to fatigue . . . low cost. Use with water, fuels, oils, gases, solvents, refrigerants, conventional and non-flammable hydraulic fluids. Available with reusable couplings in a range of sizes from 3/16 thru ¾ ID and larger. A-4619A

SYNFLEX

Products Div.

Samuel Moore & Co.

Mantua, Ohio

Circle **106** on Reader Service Card

POST SCRIPTS OF INDUSTRY

tablish and supervise the network. The company's fluid couplings include the Roto Lock couplings for both aerospace and industrial applications, the Trigger Lock no-air-inclusion couplings, a line of commercial and cryogenic couplings, and other coupling designs now being planned.

Commercial Filters—RAD merge

RAD, Inc., a Cincinnati R & D firm, merged as a division with Commercial Filters Corp., Melrose, Mass. Michael F. Schaible became president, replacing Robert L. Fielding, who is now vice-chairman of the board. Alfred F. Duemler, Jr., former RAD vice president, is vice president and treasurer of Commercial. Carl F. Holland, former sales manager of Commercial's Honan-Crane and Delpark lines, is general sales manager. E. John Van Lier, formerly of Purolator Products, Inc., is chief product engineer. Fred C. Valentin, who was Purolator's manager of mfg. engineering, is chief mfg. engineer. Charles T. Rose, formerly of Walker Mfg. Co., Racine, is chief industrial engineer.

Schaible

Zecher

Bendix Filter names quality control manager and sales engineer

Appointment of John R. Baker as quality control manager for Bendix Filter Division, Bendix Corp. is announced. Mr. Baker has been with the firm since 1953. He has had over 15 years experience in fluid systems engineering. Emil V. Zecher has been appointed sales engineer in the New England region. He will provide sales and application engineering assistance to users of high performance filters.

Owatonna names sales manager, appoints representatives

S. L. Richmond has been appointed sales manager of Owatonna Tool Co., Tools and Equipment Division. Richmond will direct the sale of all OTC lines through industrial and automotive distributors and jobbers.

Ralph W. Long has been named district sales representative for the Tool & Equipment Division in central California and Clark County, Nevada. Gordon F. Packer is the division's new district sales representative for southern California and Arizona.

New general manager for Ward Hydronics

Ward Hydronics, Inc., of Alden, N. Y., recently appointed John

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Quick, on-the-spot calibration of pressure gauges, transducers and their systems with a compact unit.

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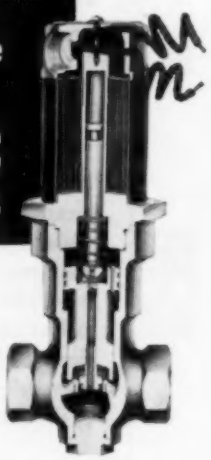

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write for Atkomatic Catalog no. 444

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R. Link as general manager. Prior to joining WH, he was a sales engineer for eight years at E. F. Houghton & Co. Link is a member of the American Society for Metals and the Technical Association of the Pulp and Paper Industry, and he has a ME degree.

Link

Rogge

Rogge heads new Aeroquip division

William F. Rogge, has become general manager of Aeroquip Corp. Industrial Div. which will include all industrial manufacturing and marketing throughout the United States. Headquarters will be in Jackson, Mich.

Denison names sales manager

D. E. Ligon was named field engineer for the Southwest for Denison Engineering Div., American Brake Shoe Co., Columbus. His territory includes Arkansas, Colorado, Kansas, and Oklahoma. Headquarters will be in Tulsa. He was previously office manager of Denison's Houston branch.

Ligon

Bauer

Jamesbury names Bauer to sales staff

Jamesbury Corp., Worcester, Mass., has added John W. Bauer to its sales staff to unify sales and engineering efforts related to the firm's government and military activities. He is a graduate of Newark College of Engineering, was most recently senior application engineer with Fenwal, Inc.

▼▼▼

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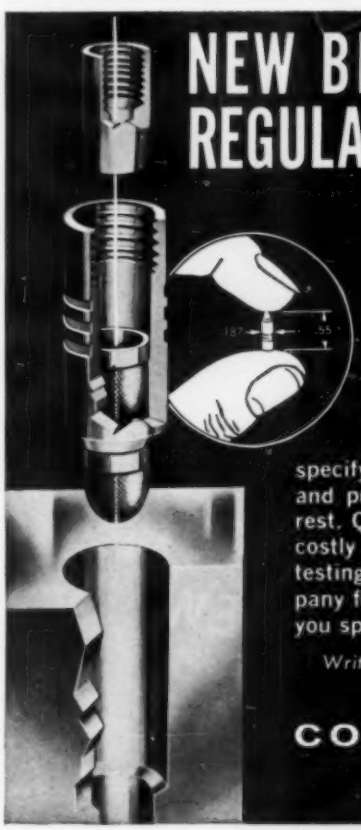

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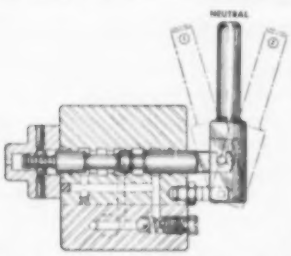

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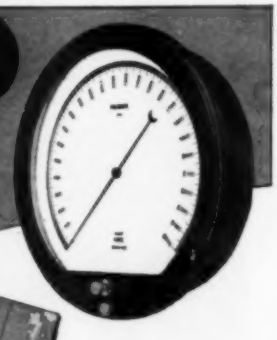

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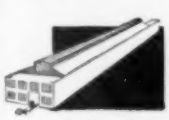

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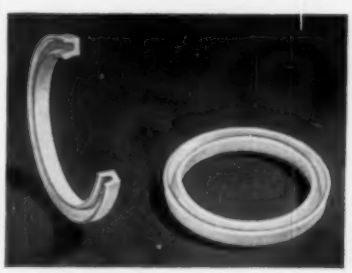

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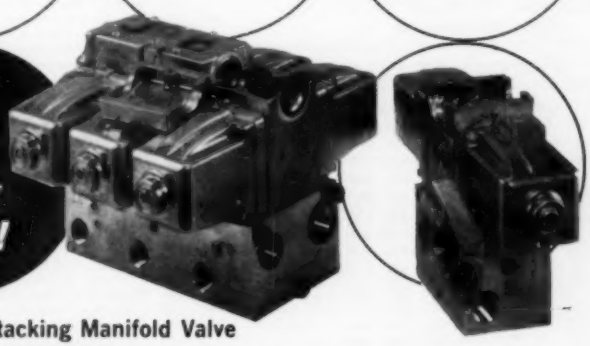

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4	19	34	49	64	79	94	109	124	139	154	169	184	199	214
5	20	35	50	65	80	95	110	125	140	155	170	185	200	215
6	21	36	51	66	81	96	111	126	141	156	171	186	201	216
7	22	37	52	67	82	97	112	127	142	157	172	187	202	217
8	23	38	53	68	83	98	113	128	143	158	173	188	203	218
9	24	39	54	69	84	99	114	129	144	159	174	189	204	219
10	25	40	55	70	85	100	115	130	145	160	175	190	205	220
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13	28	43	58	73	88	103	118	133	148	163	178	193	208	223
14	29	44	59	74	89	104	119	134	149	164	179	194	209	224
15	30	45	60	75	90	105	120	135	150	165	180	195	210	225

NEW PRODUCTS

300	315	330
301	316	331
302	317	332
303	318	333
304	319	334
305	320	335
306	321	336
307	322	337
308	323	338
309	324	339
310	325	340
311	326	341
312	327	342
313	328	343
314	329	344

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400	415	430
401	416	431
402	417	432
403	418	433
404	419	434
405	420	435
406	421	436
407	422	437
408	423	438
409	424	439
410	425	440
411	426	441
412	427	442
413	428	443
414	429	444

AEROSPACE DATA

500	515	530
501	516	531
502	517	532
503	518	533
504	519	534
505	520	535
506	521	536
507	522	537
508	523	538
509	524	539
510	525	540
511	526	541
512	527	542
513	528	543
514	529	544

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4	19	34	49	64	79	94	109	124	139	154	169	184	199	214
5	20	35	50	65	80	95	110	125	140	155	170	185	200	215
6	21	36	51	66	81	96	111	126	141	156	171	186	201	216
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10	25	40	55	70	85	100	115	130	145	160	175	190	205	220
11	26	41	56	71	86	101	116	131	146	161	176	191	206	221
12	27	42	57	72	87	102	117	132	147	162	177	192	207	222
13	28	43	58	73	88	103	118	133	148	163	178	193	208	223
14	29	44	59	74	89	104	119	134	149	164	179	194	209	224
15	30	45	60	75	90	105	120	135	150	165	180	195	210	225

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502	517	532
503	518	533
504	519	534
505	520	535
506	521	536
507	522	537
508	523	538
509	524	539
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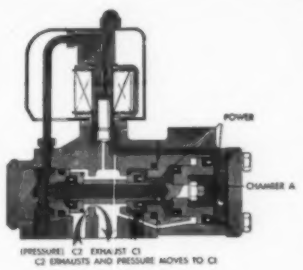

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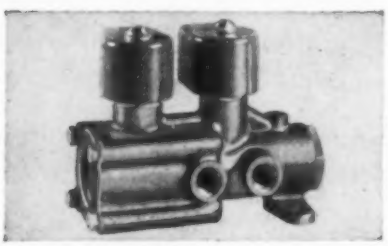

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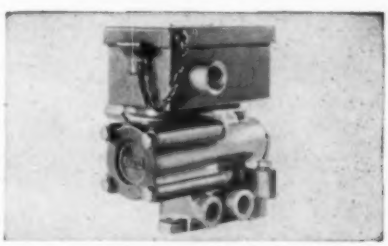

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